UNIVERSIDADE CATÓLICA PORTUGUESA

The Value of Fundamentals in Agricultural Futures Markets

An Event Study Approach Using WASDE Reports

Dissertation submitted for the degree of MSc in Finance

by

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Abstract

The purpose of this dissertation is to study the impact and information value of the World Agricultural Supply and Demand Estimates (WASDE) reports in soybeans, wheat and corn futures contracts traded in the Chicago Board of Trade (CBOT) and in wheat and corn futures contracts traded in Euronext over the period 1998 to 2012. The research is based on an event study approach, with the "events" consisting of all monthly WASDE reports releases.

Overall, for CBOT commodities, results suggest that WASDE reports months including National Agricultural Statistics Service (NASS) crop production estimates have the largest impact; causing return variance on report sessions to be between 4 and 7 times greater than normal return variance. For the group of months including only WASDE reports, the impact is substantially smaller. The CBOT results also show that the impact of WASDE reports has decreased in the sample sub-period from 2006 through 2009. This period observed unprecendented agricultural prices volatily, with the largest inflow of money into agricultural commodities futures in history. Also, a new market participant, index traders, came to play a major role in agricultural futures market structure.

For Euronext commodities, results indicate that WASDE reports have a much smaller impact. However, a similar pattern to the one evidenced in CBOT is found, since WASDE and NASS reports months also have the largest impact; causing return variance on report sessions to be about double than normal. The Euronext results suggest that the impact of WASDE reports has increased over time.

Key words: *event study, WASDE, NASS, impact, CBOT, Euronext, futures, return variance*

JEL Classification: *C12, D84, G14, Q11, Q13*

Resumo

Esta dissertação tem como propósito estudar o impacto e o valor da informação contida no relatório *World Agricultural Supply and Demand Estimates* (WASDE) nos contractos de futuros de soja, trigo e milho transaccionados na *Chicago Board of Trade* (CBOT) e nos contratos de futuros de trigo e milho transaccionados na Euronext entre 1998 e 2012. O estudo baseia-se na metodologia de estudos de evento, em que os "eventos" são as publicações mensais dos relatórios WASDE.

Em geral, para as *commodities* transaccionadas na CBOT, os resultados sugerem que os meses em que os relatórios WASDE incluem as estimativas de produção das colheitas da *National Agricultural Statistics Service* (NASS) são os que têm um maior impacto; causando uma variância do retorno na sessão da publicação do relatório entre 4 e 7 vezes maior que a variância do retorno das restantes sessões. Para o grupo de meses que incluem apenas os relatórios WASDE, o impacto é substancialmente menor. Os resultados também evidenciam que o impacto dos relatórios WASDE diminuiu entre 2006 e 2009. Este periodo foi marcado por uma volatilidade invulgar nos preços dos bens agrícolas, sendo ainda o qual registou o maior fluxo de investimento em contratos de futuros de *commodities* agrícolas na história. Adicionalmente neste período, um novo participante, *index traders*, passou a ter um papel importante na estrutura do mercado de futuros agrícolas.

Para as *commodities* transaccionadas na Euronext, os resultados indicam que os relatórios WASDE têm um impacto substâncialmente menor. No entanto, são descobertos padrões semelhantes aos registados na CBOT, uma vez que os meses que englobam os relatórios WASDE e NASS são também os que têm maior impacto; causando uma variância do retorno na sessão da publicação do relatório ser cerca do dobro das restantes sessões. Os resultados para as Euronext *commodities* também sugerem que o impacto dos relatórios WASDE aumentou ao longo dos anos.

Palavras chave: *estudos de evento, WASDE, NASS, impacto, CBOT, Euronext, futuros, variância do retorno*

Classificação JEL: *C12, D84, G14, Q11, Q13*

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List of Abbreviations

CBOT	Chicago Board Of Trade
CME	Chicago Commodity Exchange
FAO	Food Agricultural Organization
GDP	Gross Domestic Product
IMF	International Monetary Fund
NASS	National Agricultural Statistic Service
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
US	United States
USDA	United States Department of Agriculture
WASDE	World Agricultural Supply and Demand Estimates

1. Introduction

Agricultural market participants permanently face the uncertainty and unpredictability nature of agricultural markets regarding prices and production that will prevail in the next crops harvests. The production uncertainty arises from factors such as weather conditions, diseases, and insect damages, while price uncertainty - risk - is influenced by factors of supply and demand. Participants, facing these market intrinsic characteristics, soon perceived the importance of risk management and of a proper understanding over agricultural market structure and the underlying dynamics.

The establishment of an Agricultural Futures Market Exchange in 1865 allowed farmers and merchants to hedge against price risk in an organized basis. To reduce the uncertainty and inform market participants about current and expected market conditions for several commodities, the United States Department of Agricultural (USDA) publishes the monthly World Agricultural Supply and Demand Estimates (WASDE) report. Both, futures markets and WASDE reports, have long been regarded as extremely important for the well-functioning of markets and to facilitate effective decision-making in this uncertain agricultural environment (Schnepf, 2006, p. 15).

However, since the turn of the new millennium, agricultural futures prices reached unprecedented highs, and was registered the largest inflow of money into agricultural commodities futures in history. Also, a new market participant came to play a major role – index traders. These facts, alongside with an unambiguous causal relationship for the dynamics in agricultural fundamentals (supply and demand drivers), together instituted questions on whether the very function of agricultural futures markets has changed and on the information value of WASDE reports.

Considering the exposed problematic, this dissertation aims to contribute to the debate on the value of fundamentals in agricultural futures markets, by quantifying the impact of WASDE reports releases. Attending that an improved understanding of market reactions following WASDE reports releases benefits market participants, this topic is of interest to futures market participants that trade relying on fundamentals information. It is conducted an event study around the release of WASDE report and mean price reaction tests are used to find empirically evidence on the information value of WASDE reports. The release of a WASDE report impacts return variance, it is assumed that reports cause changes in market participants' expectations and reduce the uncertainty regarding the subsequent distribution of futures/spot prices. Additionally, it is presented the impact of WASDE reports releases in context for Chicago Board of Trade (CBOT) commodities.

This study is in line with the methodology proposed by Irwin *et al.* (2001) and Isengildina-Massa *et al.* (2008). Both studies follow the insights and practice of Sumner and Mueller (1989) and Fortenbery and Sumner (1990), who were pioneers in measuring the impact of WASDE reports in agricultural commodities futures.

The dissertation is structured as follows. Chapter 2 presents a detailed review of the most recent and supported findings of the large body of agricultural economics research will be presented and analyzed. The literature review is organized along a number of different fundamentals and financials factors that potentially generated the recent swings in agricultural commodities prices. Chapter 3 purposes the theoretical framework outlined and assumptions to conduct the empirical analysis. Chapter 4 describes the empirical analysis results, in which is included a discussion and final remarks. Finally, chapter 5 concludes.

This work offers two new insights. Firstly, the impact of WASDE reports releases in European agricultural commodities futures market (Euronext) is quantified. Secondly, the impact of WASDE reports in CBOT futures market after 2006 is quantified. Empirical results found evidence of a small impact of WASDE reports releases in Euronext and for CBOT commodities that the impact of WASDE reports has decreased substantially from 2006 through 2009, suggesting that market conditions changes might have been responsible for the unusual volatility in agricultural futures prices.

2. Literature Review

The literature review is divided in three sections. The first section presents the basis of agricultural futures. The second section identifies the agricultural commodities futures price trends since the turn of the new millennium and the main supported reasons for the recent price dynamics. The last section exposes the empirical evidence and suggestions on the economic value of fundamentals in agricultural commodities futures markets.

2.1. The Basis of Agricultural Futures

2.1.1. The Foundations of Agricultural Futures Markets

The need for an agricultural futures market "stems from the fact of agricultural production being characterized by an irreducible level of unpredictability: harvest vary" (Sprat, 2013, p. 4). As a result, agricultural products prices are more unstable over time than most nonfarm goods and services (Schnepf, 2006).

By the early 1850s in Chicago, to overcome the possibility of adverse price developments on the spot markets, agricultural producers (farmers) began to sell their agriculture commodities to the Chicago merchants on time contracts, or forward contracts, on which they previously fixed the price and the delivery date. These forward contracts became the usual way of doing business, and, according to the Chicago Mercantile Exchanges (CME) Commodity Trading Manual (2006), speculators soon became interested, willing to accept price risk in exchange of potential profits and with no intention of holding the commodity at maturity.

During that time, contracts were changing hands many times before the actual delivery date and the lack of a regulated market was generating a chaotic situation (Schnepf, 2006). As a consequence, was established the world's first Futures Exchange Market, the CBOT, and the first Future contract was formalized in 1865.[1]

[1] "CBOT formalized grain trading with the development of standardized agreements called "futures" contracts, world's first such agreements CBOT creates world's first futures clearing operation when it begins requiring performance bonds, called "margin", to be posted by buyers and sellers in its grain markets." (CME, 2006)

2.1.2. Agricultural Futures Exchange Markets: Purpose and Functions

According to Schnepf (2006) and Hull (2008) the Commodity Futures Exchanges made trading possible, by specifying certain standardized features of futures contract and publishing information on the months for which futures contracts are available, the contract size, deliverable grades, trading hours, contract period, daily price limits, minimum price fluctuations, and margin information. These standardized features are defined to ensure that futures closely mirror cash market conditions.

Schnepf (2006, p. 6) argues that, as a result of the futures exchanges activity, "futures market function as a central exchange for domestic and international information and as a primary mechanism for spot price discovery, particularly for storable agricultural commodities with seasonal production patterns". Alongside with this point of view, many authors (McKenzie, 2008; Baldi *et al.*, 2010; Staritz, 2012; Girardi, 2012) agree that futures prices play an important price discovery role in the marketing of storable agricultural commodities. Baldi *et al.* (2010) went further and investigated the spot-futures price relationship in corn and soybean markets. Their results strongly suggest that corn and soybean futures prices are used as a benchmark for spot prices and that changes in futures prices tend to lead changes in spot prices.

In futures markets, the difference between the spot price and the price of a nearby future contract is called the basis. The basis, as the CME (2006) describes, normally reflects the transportation costs, associated with moving the commodity from the local market to the delivery point specified by the futures contract, and the carrying charges (storage, interest and insurance costs) of holding the commodity between the future contract transaction date and the delivery. Schnepf (2006) investigated the basis movements for storable agricultural commodities futures and verifies that they have been shaping generally repetitive patterns from year to year. Thus, as the author suggest, the basis predictability is enabling users to estimate an expected spot price from the currently report value of futures contracts and to reduce the risk of using the future markets to hedge or forward contract.

Agricultural commodity futures contracts are now traded all over the world and the major commodities traded, according to the United States Department of Agriculture (USDA), are Corn, Soybean and Wheat (see Appendix 1 and Appendix 2).

2.1.3. Agricultural Futures Market Participants

The Chicago Futures Trading Commission (CFTC) conventionally recognized two types of typical participants in the futures markets. On one side, there are commercials or institutional commodities producers (farmers) or consumers who trade futures to hedge the risks associated with physical commodities. On the other side there are speculators (financial investors) who are not hedging such risks but simply taking position in the market and attempt to profit from price changes in future contracts (CME, 2006).

"Although speculation in commodity futures is sometimes referred to as gambling, this is an inaccurate reference" (Lerner, 2000, p. 5). Speculators, or financial investors, play a major role in commodity futures market (Lerner, 2000; CME, 2006). Following the CME Traders Guide to Futures (2006) point of view, while futures help hedgers manage their exposure to price risk, the market would not be possible without the participation of speculators. Speculators provide "the bulk of market liquidity, which allow hedgers to enter and exit the market in an efficient manner" (CME, 2006, p. 6).

Despite the CFTC traditionally recognized only those two kinds of participants, more recently a third type of investors came to play a major role. They are known as Commodity Index Investors (also named as "CIT investors" or "Index traders"), and according to Borin and Nino (2012, p. 11), they "use agricultural commodity futures as alternative investment assets as part of a portfolio diversification strategy and are less concerned with the evolution of fundamentals". [2]

[2] According to Burch *et al.* (2012, p. 59), "Commodity Index Funds are financial investment products that track prices of a bundle of commodities. Typically 15-30% of the fund is made up of agricultural commodities (the rest is comprised of minerals, oil, etc.). The Goldman Sachs Commodity Index (GSCI), the AIG Commodity Index, and Dow Jones USB index are perhaps the best-known products."

The CFTC, in order to improve transparency in futures markets, publishes on a regular basis the Commitment of Traders (COT) report and the Supplementary Commodity Index traders (CIT) report, in which traders' positions during the week for 12 agricultural commodities are reported (UNCTAD, 2011).

Finally, regarding the role of each future market participant, the conclusion of CME (2006, p. 6) is that "regardless their approach, each market participant plays an important role in making the futures market an efficient place to conduct business".

2.1.4. Fundamentals in Agricultural Futures Markets

As mentioned previously, agricultural futures markets are subject to considerable uncertainty regarding prices and quantities (Karali and Thurnman, 2010; Spratt, 2013; Irwin *et al.*, 2001). This market characteristic requires higher levels of regulation and transparency of information concerning physical supply and demand fundamentals in international agricultural commodity markets, in order to allow market participants to form accurate expectations on prices (Fajarnes, 2011; See Appendix 3 for an overview on agricultural commodities price formation).

According to Fajarnes (2011), fundamentals are the dominant factors influencing medium to long-term trends in agricultural prices (futures and spot). The author also supports that data on supply expectations, weather conditions, crop plantings and harvest forecasts play a major role in these markets. This information is crucial to the efficient functioning of the agricultural futures market (Garcia and Irwin *et al.*, 1995), thus there are several sources and entities providing it.

The United States Department of Agriculture (USDA) is one of those entities, who routinely release a series of commodity market information reports to the public including the US and other nation's crop production and commodity marketing activity for historical, current and future periods (See Appendix 4).

The agricultural commodities crop estimates, projected supply and demand conditions, and commodity prices projections included in USDA reports are widely accepted and used as a benchmark in the marketplace because of their "comprehensive nature, objectivity, and timeliness" (Isengildina-Massa *et al.,* 2008, p. 90). Therefore, market participants watch closely the releases of USDA reports, due to their potential impact on market expectations concerning the current and future commodity market conditions (Schnepf, 2006; Adjemian, 2011; Bangue and Vogel, 1999).

Though most of USDA reports contain valuable and timely information, there is a monthly report that grabs the attention of a broad spectrum of market participants. It is the World Agricultural Supply and Demand Estimates (WASDE) report. Schnepf (2006, p. 15) describes WASDE reports as the "cornerstone of USDA reports". Isengildina-Massa *et al.* (2008, p. 90) argue that this report is "unique compared to most other USDA reports because it contains both situation and outlook information".

The monthly WASDE report provides a commodity-by-commodity and country-by-country (U.S. and others major world countries' producers) brief balance sheet of supply and demand estimates, consumption, and stocks for numerous crops (e.g. corn, wheat, soybean, cotton, rice). The report from August through November plus January is released simultaneously with the Crop Production Report in order to incorporate the new US National Agricultural Statistic Service (NASS) crop production estimates into the commodity supply and demand estimates. In those months, it is also supplemented with a monthly commodity situation and outlook report (Isengildina-Massa *et al.*, 2008; Schnepf, 2006).[3]

The USDA WASDE report and the NASS Crop Production report are prepared simultaneously in a secure environment, known as "lock-up", and since May 1994 are released at 8:30 a.m. Eastern Time, before the trading start at CBOT, and is released between the 9th and 12th day of each month (Bange and Vogel, 1999).

Notwithstanding the apparent economic value of WASDE reports, its economic welfare benefits have long been regarded as questionable. This issue will be explored in the last section of the literature review.

[3] According to Schnepf (2006), NASS publishes Crop Production Reports, which contain production estimates for oilseeds, grains and cotton grown in the US, based on data collected from farm operations and field observations. The reports also include estimates of prospective planting, harvest acreage, yield and production forecasts.

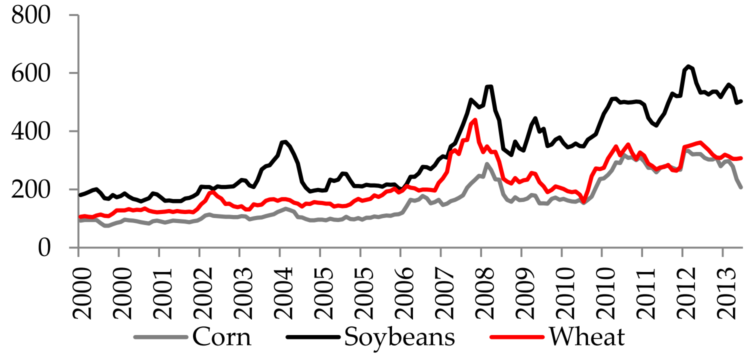
2.2. Recent Agricultural Price Dynamics

Although price volatility has long been a major feature of agricultural markets, the recent developments over the mid-2000s have been exceptional in many ways. On the one side, agricultural commodity prices reached historical highs, on the other side the commodity futures market conditions have changed drastically, and together instituted the issue on "whether the very function of commodity markets has changed" (Flassbeck *et al.*, 2011, p. 1).

2.2.1. An Overview on the Recent Agricultural Price Dynamics

According to several official entities as the IMF, UNCTAD and FAO, since the turn of the new millennium the agricultural commodities prices have experienced unprecedented highs and unusual volatility. Following Sprat (2013), from around 2002, prices started to increase steadily and after a sharply rise in 2007, culminated with prices reaching historic highs in the middle of 2008. This price surge was, for major agricultural commodities, like wheat and corn, the highest since 1973-74. In October 2008, this price upswing decelerated and prices declined abruptly in the midst of the financial crisis (subprime) and the wake of the deepest economic recession since 1930 for most global nations (Rapsomanikis and Sarris, 2010). Afterwards, although many agricultural commodities prices felt more than 40% from their peaks in June 2008, they remained by December 2008 at a significantly higher level than before 2005. More recently, prices spiked again in early 2011 at levels slightly higher than those reached in 2008. Thereafter, prices in general appear to have been declining to 2008 levels, as Figure 1 shows.

Figure 1 - Major Agricultural Price Dynamics



Source: Based on International Monetary Fund (IMF) database (website).
Note: Spot prices are in US dollars per metric ton, according to IMF terminology

These price swings over the last decade have been a topic of interest for a considerable number of studies, which aim to investigate and relate fundamental drivers with the recent agricultural commodities price spikes. However, as Flassbeck *et al.* (2011) claim, fundamental factors alone are not sufficient to explain the recent developments in agricultural commodities prices. Moreover, Mayer (2009), in agreement with Flassbeck *et al.* (2011, p. 1) point of view, suggests that, "beyond the specific function of agricultural commodities markets, broader macroeconomic and financial factors, that operate across a large number of markets, need to be considered to fully understand futures markets". Both authors, through their arguments, pretend to introduce a new major factor - the *financialization* of agricultural futures markets.

2.2.2. The *Financialization* of Agricultural Futures Markets

For Flassbeck *et al.* (2011, p. 13) "Financialization of commodity trading indicates the increasing role of financial motives, financial markets and financial actors in the operation of agricultural commodity markets".

According to Mayer (2009), financial investors have been active on agricultural commodities futures markets since the early 1990s. However, after the equity market bubble in 2000, the growing acceptance of the notion that "commodities as an asset class are a quasi-natural hedge against positions in equity markets" (Flassbeck *et al.*, 2011, p. 13; Gordon and Rouwenhorst, 2004) spurred financial investors' attention towards agricultural futures markets. The referred belief emerged in some manner, as a result of the empirical analysis carried out by Gordon and Rouwenhorts (2004), who through an equally weighted index of commodity futures covering the period between July 1959 and March 2004 found that commodities futures returns were negatively correlated with equities and bonds over most horizons, and that are also less volatile.

One way to gauge the influence of financial investors on agricultural commodities futures markets is through the CFTC weekly reports - the COT report and CIT report. These reports contain reliable data on US futures market participants' net positions only for the 2006-2012 period, as presented in Table 1.

Table 1 - Agricultural Futures Market Structure, 2006-2012

(Millions of Contracts)

Panel A - Wheat Futures – Chicago Board of Trade (CBOT)

	Volume	%	Long Position	%	Short Position	%
Commercial Hedgers	**70**	**31%**	**13**	**19%**	**56**	**81%**
Financial Investors	**125**	**55%**	**88**	**70%**	**38**	**30%**
Money Managers[1]	45	20%	24	54%	21	46%
CIT Investors [2]	81	36%	64	79%	17	21%
Non Reported Positions	**31**	**14%**	**12**	**38%**	**19**	**62%**
Total	**226**		**201**		**150**	

Panel B - Corn Futures – Chicago Board of Trade (CBOT)

	Volume	%	Long Position	%	Short Position	%
Commercial Hedgers	**305**	**43%**	**79**	**26%**	**226,1**	**74%**
Financial Investors	**278**	**39%**	**229**	**82%**	**48,8**	**18%**
Money Managers[1]	102	14%	81	79%	21,3	21%
CIT Investors [2]	176	25%	149	84%	27,6	16%
Non Reported Positions	**127**	**18%**	**47**	**37%**	**80,2**	**63%**
Total	**710**		**585**		**404**	

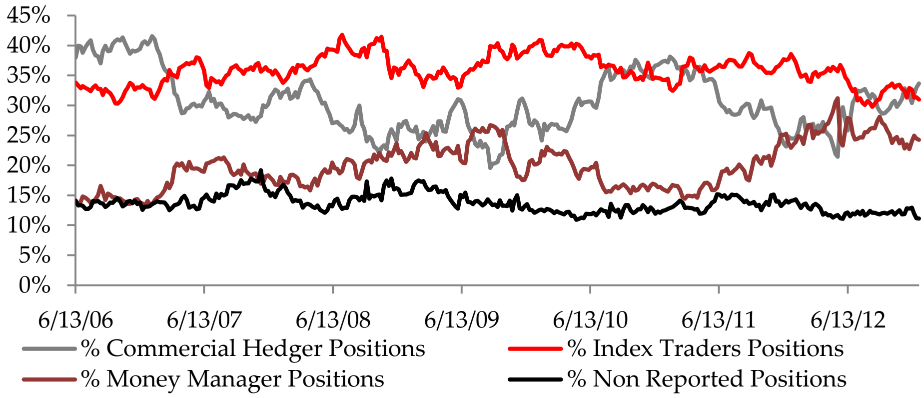
Panel C - Soybeans Futures – Chicago Board of Trade (CBOT)

	Volume	%	Long Position	%	Short Position	%
Commercial Hedgers	**128**	**44%**	**31**	**24%**	**97**	**76%**
Financial Investors	**116**	**40%**	**96**	**82%**	**20**	**18%**
Money Managers[1]	45	16%	37	82%	8	18%
CIT Investors [2]	71	24%	59	83%	12	17%
Non Reported Positions	**46**	**16%**	**18**	**39%**	**28**	**61%**
Total	**290**		**241**		**166**	

Source: Based on CFTC CIT and COT report data.
Note: (1) Money Managers: traditional speculators – individual investors or investment funds; (2) CIT Investors: as referred previously, Commodity Index Investors – big investment banks.

According to CFTC, financial investors held from 2006 to 2012 an average market share of more than 40% in the most traded agricultural commodities (wheat, corn and soybeans) in the US major agricultural exchange (CBOT). The large majority of this financial investment (60%) came from CIT investors. However, for instance in the case of wheat futures, there were periods in June and October of 2008 that Money Managers (traditional speculators) held more than 20% and CIT investor more than 40% of wheat futures contracts (see Figure 2).

Figure 2 - Wheat Futures Market Structure (CBOT)



Source: Based on CFTC database (website).

Another way to verify the increasing role played by financial investors is through the Open Interest – the size of commodity futures market.

Figure 3 - Open Interest

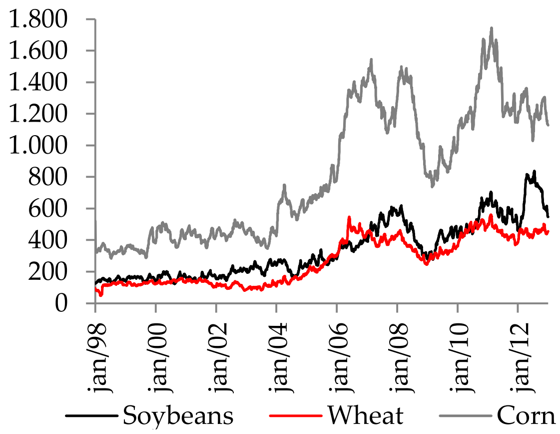
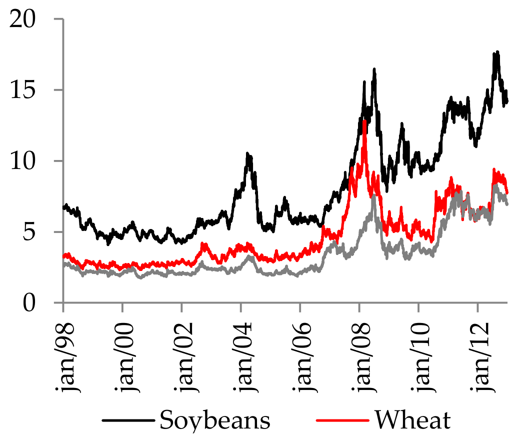


Figure 3 - Nearby Futures Contracts



Source: Based on Thomson Financial DataStream.
Note: (1) Open Interest: Total number of CBOT commodities futures contracts that have not yet been exercised, expired, or fulfilled by delivery (thousands of contracts); (2) Prices of futures contracts with the closest delivery data. (2) Prices are in $ per bushel.

As the new century began and following CFTC data reports, the open interests for the major agricultural commodities traded on CBOT more than tripled on average (see Figure 3). Moreover, this increase in agricultural commodities futures trading was accompanied with a widespread rise in prices (see Figure 4). The value of outstanding positions in CBOT for soybeans, wheat and corn increased from about 134, 122 and 392 thousands contracts in 2000, respectively, to almost 546, 456 and 1,128 thousands contracts in 2012, respectively. Concerning prices, during the covered period the prices of the above mentioned commodities more than doubled, and in some occasions prices were more than 5 times their lowest value. For instance, in March 2008, wheat futures price was at $12.8 per bushel, whereas in August 2000 was at $2.3 per bushel.

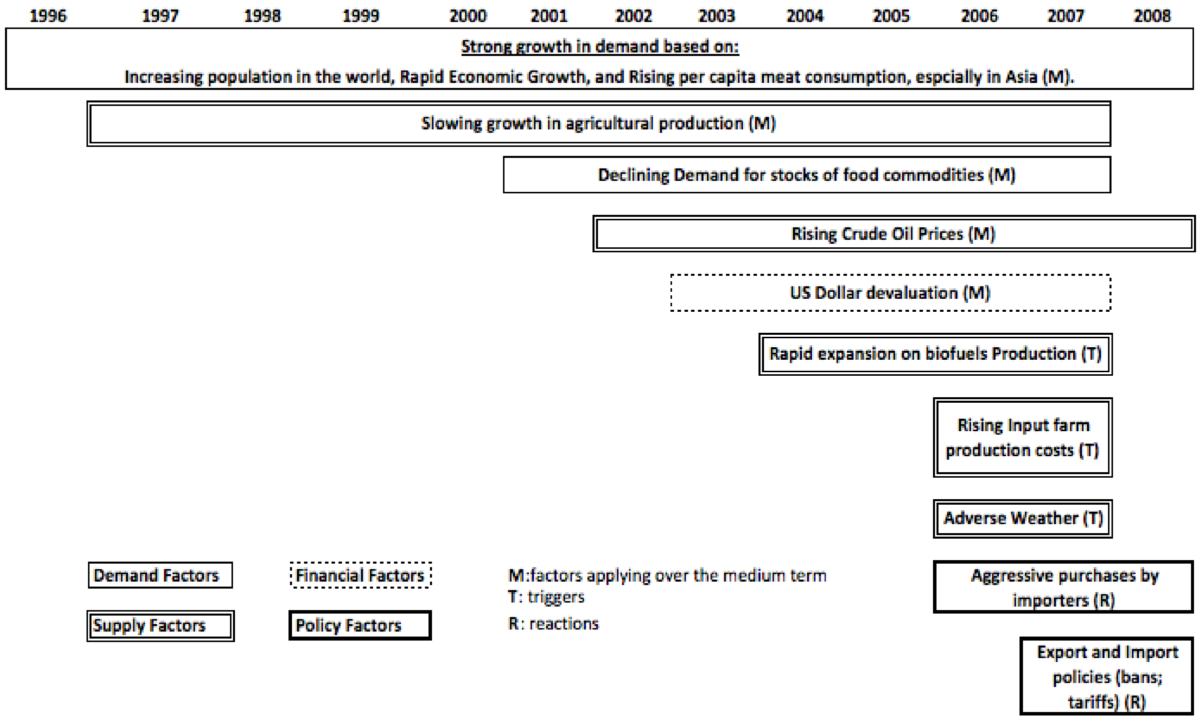
Attending to the ambiguous cause and effect relation between agricultural price swings, fundamentals and the recorded drastic changes in agricultural commodities futures markets over the last years, the next section will review the literature offering reasons on whether the price spikes were driven by fundamentals or speculation.

2.2.3. Agricultural Price Spikes: Fundamentals or Speculation?

Wiggins *et al.* (2010, p. 3 and 4), on a general overview, suggest that the literature covering this topic distinguishes between agreed and disputed causes for the price spikes. The authors suggest there is general agreement on most of the causes for the 2008 price spikes, in which they include: "poor harvests, low cereal stocks, rising oil price, generalized inflation, export bans and restrictions, restrictions in tight markets, reduced import tariffs, and depreciation of US dollar". Additionally, they consider other three causes with a contested role, though with an estimated impact, which are: "diversion of grains to distillation of biofuels – responsible for perhaps 30% of the rise in prices; the influence of rising demand in China, India and other rapidly growing economies – probably not a cause; and, speculation of futures market – controversial and difficult to prove".

Following Wiggins *et al.* (2010), Rezitis and Sassi (2013) describe the evolution of the first price spike (2008) as a combination of the general agreed factors as they arose throughout time. As it can be seen in Figure 4, they only mention fundamentals (supply and demand) and macroeconomic (trade policies and exchange rates) factors, and list those factors as a sequence of events that preceded, triggered, amplified and prolonged the upsurge in 2008 price spikes.

Figure 4 - Timeline for the 2008 Price Spike



Source: Based on Retizis and Sassi (2013)

2.2.3.1. The Role of Supply and Demand Factors

On the demand side, the most supported factors to have influenced agricultural prices are related with the rising world population, economic growth and changes in consumptions patterns from emerging economies towards superior agricultural products (Rezitis and Sassi, 2013; Flassbeck *et al.*, 2011; Wiggins *et al.*, 2010). Flassbeck *et al.* (2011) argue that the sharp rise in income in emerging economies alongside with the accelerated economic growth, particularly in China and Southeast Asia, have changed the population consumption habits, which began to demand more protein-rich diets - hence a higher consumption of meat. Taking into account, as the author refers, that agricultural commodities grains are required to feed the animals and that meat consumption rose by 50% in the referred region between 1995 and 2005, this factor could be seen as a major cause for agricultural commodities demand increase and, consequently price volatility, especially in the case of absence of inventories (Prakash, 2011).

Gilbert (2008) using a Granger-Causality test empirically proved that Gross Domestic Product (GDP) growth has been responsible for a significant part of aggregate agricultural price movements over the period 1971 through 2008. This finding supports the literature and points to the fact that as the economy grows the demand for agriculture commodities will rise and in turn push up prices.

On the supply side of agricultural commodities, three main factors are believed to have triggered the price spikes, which are: the extreme weather events; the slow-down in growth of production of cereals; and, the rising in oil prices and its consequences (Rezitis and Sassi, 2013; Flassbeck *et al.,* 2011; Wiggins *et al.,* 2010). Additionally, though inventories are related to both sides, demand and supply, they play a crucial role in the supply of agricultural commodities, since the supply side of agricultural products is highly inelastic due to their seasonal nature (Emback and Raquet, 2011).

Firstly, concerning supply side factors, Flassbeck *et al.* (2011) claim that many regions in the world already suffered supply constraints on agricultural commodities due to the effects of climate change, and that those effects are expected to grow dramatically over the next decades. Australian severe drought experienced between 2006 and 2008, was one of those regions, which left the country wheat production reduced by about 50%. In 2010, Russia, Ukraine and Kazak suffered an extreme heat wave, which according to Emback and Raquet (2011), decreased wheat production by 27%, 19% and 35%, respectively. Nonetheless, Lagi *et al.* (2011) in the case of the massive droughts in Australia, demonstrates that the fraction of global grains produced in the country (around 1.8% by weight in 2010) is not sufficient to be a significant causal factor at the magnitude of influence of the 2008 price changes. Moreover, they generalize that global weather conditions are unable to explain the recent food price changes.

Secondly, grains production has been growing at a slower rate since the 1990s. From the early 1970s to the early 1990s, world grain production grew strongly at an average of 2.2% a year, comfortably ahead of population growth (1.7% a year on average). Subsequently, however, from 1990 till 2007 total world grain production has slowed markedly to an average of 1.3% a year, while population grew at an average of 1.4% a year (Wiggins *et al.*, 2010; Trostle, 2008). According to Wiggins *et al.* (2010), the slower growth of grains production contributed, along with decisions to hold smaller public stocks of grain in major developed countries, to a decline in stocks of grains from 2000 onwards. For instance, for the three main agricultural commodities (wheat, corn and soybeans) worldwide end-of-season stocks-to-use ratio fell from more than 34% in the late 1990s to nearly 18% by 2007, the lowest on record.[4]

However, as Wiggins *et al.* (2010) and as others researches believe (Piesse and Thirtle, 2009; Emback and Raquet, 2011), lower stocks in themselves cannot cause prices to rise. They need to be accompanied with any sudden and unanticipated fall in supply or rise in demand that cannot be accommodated by stocks release and so the adjustment falls largely on prices. Nevertheless, as the authors state, there is a conventional wisdom that merely low stocks could have an impact on prices: "On a world basis a stocks/use ratio for wheat under 20% has typically led to strong price advances. For corn, the comparable number appears to be under 12%. For soybeans, the critical level is below 10%" (Wiggins *et al.*, 2010, p. 5). Piesse and Thirtle (2009) agree with Wiggins *et al.* (2010) and empirically prove that the Food and Agricultural Organization Price Index moves in the opposite direction of stocks-to-use ratio.[5] This finding allowed them to consider the low stocks-to-use ratio as the single most influential factor on agricultural commodities price spikes. Furthermore, both authors, point out that all price spikes ever seen since the early 1970s (1972-73; 2007-08; 2010-11) have been associated with low stocks.

The rising in oil prices is the last factor suggested to have influenced the supply side. According to Prakash (2011) and Wiggins *et al.* (2010), the five upsurges in oil prices between 2001 and 2008, pushed up diesel, nitrogen-based fertilizer and pesticides costs, thereby raising farmers production and transportation costs. However, as Gilbert (2008, p. 11) claims, "agriculture is not highly energy-intensive" and though there is a small correlation between the real oil prices and the real food, estimated by Baffes and Haniotis (2010) at 0.17, prices changes are poorly correlated.

[4] "The stocks-to-use ratio indicates the level of carryover stock for any given commodity as a percentage of the total demand or use". (Futures Trading Charts)

[5] "The FAO Food Price Index is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices (representing 55 quotations), weighted with the average export shares of each of the groups for 2002-2004." (FAO)

Mitchell (2008) agrees and reinforces the last point of view with a conclusion that only a 15-20% increase in US food commodities production and transport costs was due to the higher oil prices.

2.2.3.2. The Role of Biofuels Production

The economic attraction of using cereals to produce biofuels was spurred by government subsidies, government targets to introduce biofuels in transportation fuels and other inducements in several countries (Emback and Raquet, 2011). As a result, farmers were attracted to produce crops needed for biofuel production (corn/maize, rapeseed and sunflower), and thus driving other crops prices higher "through substitution effects in food utilization and through competition in the use of agricultural land" (Rezitis and Sassi, 2013, p. 4). For instance, Mitchell (2008) reveals that in 2007 the US corn production area has expanded 23% in response to biofuels incentives, whereas soybeans area has declined 16%, which in turn has reduced soybeans production and may have contributed to the sharply rise of its prices between 2007 and 2008. In Europe the land shift consequences were similar, though the crop being displaced was wheat, substituted by rapeseed and sunflower.

Despite Mitchell (2008) considerations concerning the difficulty, if not impossibility, to find empirical evidence on the contribution of biofuels production to food prices, there are a number of different estimates that find a likely impact. Lipsky (2008), a former First Deputy Managing Director of the International Monetary Fund (IMF), estimates that the increased demand for biofuels account for 70% of the corn prices increase and 40% of the increase in soybean prices. Rosegrant, *et al*. (2008), estimates the impact of biofuels production on cereals prices from 2007 to 2008 to be 30%. Though researches find some empirical results, estimates differ widely due to their differences on methodologies, assumptions, time periods considered, prices and products involved (Mitchell, 2008).

2.2.3.3. The Role of Macroeconomic Factors

On an international level, the majority of agricultural commodities are traded in US dollars. Due to the US dollar substantial depreciation relatively to other major currencies throughout the last decade (e.g. USD/EUR between 2002 and 2008 depreciated about 35%) and the historical inverse relationship between US dollar and commodity prices (Mitchell, 2008), this factor is pointed as a likely cause. The rationale behind this cause, as Wiggins *et al.* (2010) argue, had a particular effect stemmed from Asian countries, which found they could afford to place more bids for cereals in dollar prices and thus generated a trend to push up prices.

Mitchell (2008) corroborates the historical evidence mentioned and, based on USDA data makes a comparison between the real trade-weighted exchange rate[6] and an index of food prices comprising the period from 2002 to 2008, which showed a general correspondence between dollar depreciation and food price increases. Emback and Raquet (2011) found similar results, but just for wheat. Their findings support the previous results that US dollar has an inverse relationship to wheat prices. Abot *et al.* (2009) also denote the same negative relationship, though they consider the causality between exchange rates and agricultural commodity prices difficult to sort out, since both are affected simultaneously by macroeconomic performance and government policies in the US and abroad. Despite Abot *et al.* (2009) previous predictions, Chen *et al.* (2008), through an investigation over the dynamic relationship between commodity price movements and exchange rate fluctuation, not only found a robust relationship between both, but also that exchange rates can be very useful to forecast future commodity prices.

Following Emback and Raquet (2011) and in summary, though some controversies remain about the impact of exchange rates over commodity prices, most of the empirical evidence stands for the direction that both have a strong inverse relationship.

To sum up, despite some researches have reached a common understanding and conclusions based on fundamentals to explain the recent agricultural commodities price movements (Piesse and Thirtle, 2009; Gilbert, 2008; Rosegrant *et al.*, 2008; Lipsky, 2008; Chen *et al.*, 2008; Mitchell, 2008; Emback and Raquet, 2011), those findings alone and the relative importance of these drivers are not yet clear (Flassbeck *et al.*, 2011). As a consequence, researches on this field have started to

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[6] "A country's trade-weighted exchange rate is an average of its bilateral exchange rates, weighted by the amount of trade with each country." (The Economist, 2012)

consider financial factors (the *financialization* and speculation) and the literature on this relationship has grown exponentially.

2.2.3.4. The Role of *Financialization*

The literature on the role of *financialization* in agricultural commodity futures prices crises can be articulated in two main bodies. On one side, there are the empirical studies that test agricultural commodity futures price dynamics in order to find evidence of excessive speculation or bubbles. On the other side, there are those who are bubble opponents and try to find evidence sustained on fundamentals and financial factors.

2.2.3.4.1. It was a Bubble

According to George Soros (Bloomberg, 2008), a bubble opponent, "You have a generalized commodity bubble due to commodities having become an asset class that institutions use to an increasing extent."

Masters (2008) testimony for the US Senate Committee on Homeland Security and Government Affairs is one of the most widely cited argument for the 2008 bubble hypothesis. Essentially in Masters opinion, institutional investors, or more precisely index traders, who embrace commodities "as an investable asset class", unequivocally affected the rapid increase in overall commodity prices from 2006-08. Masters (2008, p. 2) evidence is based on the temporal correlation between money flows and prices and as he shows "the assets allocated to commodity index trading strategies has risen from $13 billion at the end of 2003 to $260 billion as of March 2008 and the prices of the 25 commodities that compose these indexes have risen by an average of 183% in those five years". Therefore, attending that commodity fundamentals (supply and demand) were adequate, as he states based on the empirical evidences provided by other testimonies during the committee, he considers to find significant and persuasive evidence that index traders are responsible for the price surge. In result, he suggests the US congress take immediate measures to reduce index traders' speculation.

Another commonly cited argument supporting the 2008 bubble hypothesis comes from Gilbert (2008) empirical tests for extrapolative behavior on CBOT wheat, corn and soybean markets over 2006-08. His results suggest that, though there is some evidence for speculative bubbles, which may have contributed for the high prices seen in the markets, these bubbles persisted only for short periods of time (between February and March of 2008). However, he states that the major focus should be on index traders, not on traditional speculators. Furthermore and in agreement with Borin and Nino (2012) findings, he validates the last finding based on the fact that traditional speculators react to price changes rather than cause them and, hence reduce price volatility and provide the liquidity which allows hedgers to obtain counterparties. Whereas, index traders amplify price volatility, consume market liquidity and, as a result create an upward pressure on prices, as seen in the 2008 bubble. This view is also supported by Masters (2008, p. 7), who claims "index traders' provide zero benefits to the futures markets".[7]

2.2.3.4.2. It was not a Bubble

On the opposite side, stands a large number of economists that have expressed their skepticism and critics against the commodity bubble arguments mentioned above. The main argument of bubble opponents is that "additional money on futures markets does not equal more demand" (Reitizis and Sassi, 2013, p. 5). Krugman (2008) is one of those bubble opponents, who particularly refuted Masters (2008) testimony. For Krugman (2008), Masters (2008) is "really confused about the difference between paper contracts and physical stuff". As Krugman (2008) asserts, if a bubble raises market prices of a storable commodity above the equilibrium, then inventories of that commodity should increase (Reitizis and Sassi, p. 5, 2013). However, as his evidence demonstrates, inventories were declining and there were no signs of hoarding and building up inventories for most commodities during 2006-08, which for grain and food commodities were at or near historical levels. In other words, to Krugman, the size of futures contract position is irrelevant, since as seen in 2008, it had no effect on physical level of inventories (Emback and Raquet, 2011).

[7] Masters (2008, p. 6) suggests that traditional speculators "provide liquidity by buying and selling calendar spreads". While *index traders* "buy futures and then roll their positions by buying calendar spreads. They never sell. Therefore they consume liquidity and provide zero benefits to the futures market".

Irwin and Sanders (2010, p. 6 and 7) also criticize Masters (2008) testimony based on the limitations of his argument. According to the authors, Masters (2008) as well as other bubble proponents, "make the classical statistical mistake of confusing correlation with causation". In other words, they pretend to argue that simply observing a large inflow over the long side of commodity futures markets alongside with a substantial rise in prices, does not provide evidence of anything except a "logical and causal link between the two" and do not necessarily impact prices. Their point on this limitation is that commodity futures markets are different from physical markets, since with equally informed marked participants there is no limit on the number of futures contracts that can be created at a given price level and that to every long position held by index traders there exists a short counterpart. Therefore, as they state, "this implies that money flows in and of themselves do not necessarily impact prices". Moreover, their critics also follow Krugman (2008) line of thought on the point of view that index traders are purely involved in a financial transaction using commodity futures market. However, their investigation went further and empirically tested, using granger-causality statistical techniques and CFTC data, for any causal linkage between index traders' futures market activity and commodity prices.[8] In other words, if index traders' funds did cause a bubble and if such traders possess the power to dominate or even manipulate commodity futures markets. Their results confirmed their previous convictions, pointing out that, from 2007 to 2009, *index traders* funds did not cause a bubble in commodity futures markets, with stronger evidence for agricultural futures markets, and that "there is no statistically significant relationship indicating that changes in index and swap fund positions have increased market volatility" (Irwin and Sanders, 2010, p. 22,).

Aulerich, Irwin and Garcia (2013) shed further light on the agricultural commodities bubbles rejection hypothesis using non-public data from the Large Trader Reporting System (LTRS) maintained by the US CFTC[9]. The results confirm

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[8] According to Irwin and Sanders (2010, p. 12): "Granger causality is a standard statistical technique for determining whether one time series is useful in forecasting another."

[9] According to Aulerich, Irwin and Garcia (2013, p. 6), "these data are not subject to the previously-noted limitations since the non-public CFTC data files include financial index investor positions on a daily basis and positions are disaggregated by contract maturity."

earlier achievements that the recent buying pressure from index traders did not cause the massive surge in agricultural futures prices. Nevertheless, the authors consider that this result does not mean that index traders did not have any impact on agricultural futures market, since they provided some evidence against the previous supported strategy of "buy-and-hold" index traders' investments. In other words, they found that index traders' investments might have resulted in "a very slightly upward pressure" on agricultural futures prices, due to the observable tendency for index traders to increase aggregate positions when they perceived an upward trend in prices.

In summary, the literature fails to find compelling evidence that the growing presence and buying pressure from index traders' in recent years caused a massive bubble in agricultural futures prices. Gilbert (2008) finds some evidence but, as the author states, the evidence is modest, since the bubbles persisted for only short periods. However, though bubble hypothesis was rejected (Krugman, 2008; Irwin and Sanders, 2010), the *financialization* hypothesis is not rejected (Aulerich, Irwin and Garcia, 2013).

2.2.3.5. *Financialization* and Fundamentals

Baffes and Haniotis (2010), conducted an extensive literature review that covered financial and fundamentals factors associated with the 2008 price spike, which gave the authors a broad overview of how those factors react when combined. Their suggestions reveal that demand from developing economies is unlikely to cause additional pressures on agricultural commodity prices, though it may have created some pressure indirectly through energy prices. They also suggest that biofuels productions played some role on agricultural commodities prices, but less than they originally thought. Finally, they conjecture that the index traders' activity on agriculture futures commodities played a key role and have been partly responsible for the 2008 prices spike.

Lagi *et al.* (2011, p. 3) constructed a dynamic model "relating speculation to prices and analyses its price dynamics". Firstly, they started with a simple model of commodity price formation based on supply and demand fundamentals factors, for wheat, corn, rice and sugar. Their results show that the model is able to capture trends before the year of 2000, though after this date other factors apart from fundamentals play a central role in determining prices. This means that models that just treat supply and demand are not consistent with the actual price dynamics. Secondly, they constructed a model of commodity price formation based on corn to ethanol conversion (biofuel), for which they found a strong evidence for a causal link between them. Thirdly, a dynamic model of the role of trend-following speculators and their ability to cause deviation from equilibrium supply and demand prices was built. Their results on this model indicate that speculation can strongly destabilize the supply and demand equilibrium price. Finally and since in their analysis, they eliminated supply and demand factors except ethanol conversion, they built a model in order to represent only speculators and ethanol demand. Their final results provide specific evidence that the dominant causes for the two price spikes in 2008 and 2011 "are specifically due to investor speculation, while an underlying upward trend is due to increasing demand from ethanol conversion".

Flassbeck *et al.* (2011) conducted several interviews to agricultural commodity traders, financial institutions and other entities, which were closely involved in grain, cocoa, sugar and oil markets. According to the authors, none of the interviewees doubted that commodity prices were determined by the fundamentals of supply and demand in the medium to long-term. The market participants considered that the relevant fundamental factors were global demand (particularly the growing demand from China and India over the last decade), population growth, inventories and also political measures, out of which the most mentioned was the promotion of biofuels throughout the last decade. Nevertheless, the authors state that the common view across the interviewees was that the role of financial investors had recently become more important, though that their impact on prices was through the short-term.

A last remark concerning *financialization* supported by Flassbeck *et al.* (2011) and Basu and Gavin (2011) is that it generates an unaffordable situation for traditional market participants (i.e. farmers, merchants and consumers) on the agricultural commodity futures markets, due to the greater uncertainty regarding the reliability of signals emanated from commodity futures markets. Thus, as the authors conclude, since agricultural prices tend to be less driven by fundamental supply and demand factors, hedging against commodity price risk becomes more expensive, complex and may discourage long-term hedging by traditional hedgers. This point of view is against the basis predictability argument for storable commodities advocated by Schnepf (2006), as previously referred.

To conclude this section and looking at the vast amount of research and empirical findings, the role of *financialization* and of fundamentals on agricultural commodities futures markets over the last decade still remains uncertain. The empirical findings consider that several factors have contributed to the recent agricultural commodities price spikes. However, as Wiggins *et al.* (2010) conclude, yet the relative weight or explanation power of each factor continues to be an area of contention, mainly because they acted in combination (what the author calls "a perfect storm"). Nonetheless, it seems reasonable to consider that it was not a bubble caused by speculators (Krugman, 2008; Irwin and Sanders, 2010) and that three factors remain as the main perceived factors that have triggered the price spikes: the *financialization;* the arise of a growing demand for food commodities from emerging economies; and biofuels production (Baffes and Haniotis, 2010; Flassbeck *et al.*, 2010; Lagi *et al.,* 2011). Moreover, researches continue to believe that fundamentals indeed are crucially important in explaining agricultural commodities price movements (Marone, 2008).

2.3. Measuring Fundamentals Value in Agricultural Commodities Markets

The essence of futures market in agricultural commodities markets requires that participants have informed expectations regarding market fundamentals and that futures prices reflect all available information (McKenzie, 2008).[10]

As previously mentioned, a source of information that is available for participants and that is traditionally argued to contain crucial information to the

[10] Price discovery function: "under efficient markets, future prices represent the conditional expectation of spot prices at contract maturity" (Isengildina-Massa *et al.*, 2008, p. 93).

efficient functioning of commodity futures markets are the USDA reports (Garcia *et al.*, 1996). Assuming agricultural futures market efficiency, one would infer that price reactions following a USDA report release indicate that these reports "realign and improve expectations among participants, leading to better resource allocation decisions" (Adjemian, 2011, p. 240). In other words, and as the Efficient Market Hypothesis (EMH) would assert, as new fundamental information becomes available (in USDA releases), futures prices should immediately adjust to the "news" to reflect a change in rational participants' price expectations (McKenzie, 2008).[11] Otherwise, and according to the EMH, prices should stay flat as they already incorporate/reflect all known information (Marone, 2008).

Using USDA reports, a large body of agricultural economics empirical research tested whether agricultural commodity futures markets conform to an Efficient Market (EMH), by hypothesizing that significant changes in market prices following a USDA report announcement are an indication that the report was "newsworthy" (McKenzie, 2008). For that, most of these price reaction studies have used a variant of the event study methodology. According to Irwin *et al.* (2001) and following Campbell and Mackinlay (1997), the basic notion of an event study approach is: "in an efficient market, if prices react to the announcement information ("the event"), then the information is valuable to market participants" (Irwin *et al.*, 2001, p. 2).[12] More precisely and following McNew and Espinosa (1994), the information is valuable if it affects the mean (price level) and/or volatility (standard deviation/ uncertainty) of the expected distribution of agricultural commodities futures prices.

However, as Garcia *et al.* (1996) presented, the value of USDA reports (public commodity information) has been challenged from several perspective, since it is argued that private information services can substitute public programs.

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[11] An efficient market, as Eugene Fama, defined in 1970, "is a market in which prices "fully reflects" all available information" (Fama, 1970, p. 383). Moreover, "Under the Efficient Market Hypothesis, a test of information value is whether market prices react to unanticipated information" (Garcia *et. al.*, 1997, p. 563).

[12] The event study frameworks presented in a wide number of studies assume markets are not strong-form efficient. Under strong-form efficient hypothesis, prices always fully reflect all the available public and private information. However, since most studies reject the strong-form efficiency hypothesis for all types of markets, including agricultural futures markets, most event studies in financial economics and agricultural economics implicitly assume markets are less than strong-form efficient (Fama, 1970; Isengildina-Massa *et al.*, 2008).

Nevertheless, the majority of studies find significant market price reactions to the announcement of USDA reports for most agricultural commodities, as it will be presented in the following topic.

2.3.1. Price Reaction to WASDE Reports Releases in Agricultural Futures Market

The first study was conducted by Sumner and Mueller (1989) and focused on the daily movements of CBOT corn and soybeans futures closing prices in response to the release of USDA harvest forecasts for periods of 12 trading days surrounding USDA announcement dates for the years 1961 to 1982.[13] Their results provided a variety of evidence that USDA harvest forecasts reports releases affect market price movements and, thus that significant information is contained in these reports. More specifically, they found that releases in August, September and October appear to have the strongest impact on daily changes of futures market closing prices for both corn and soybeans.[14] They also suggest that market participants have reacted more to the USDA harvest forecast reports releases between 1961 and 1979 than from 1980 to 1982.

Consistent with last study findings is the Fortenbery and Sumner (1990) investigation over CBOT corn and soybeans futures (closing prices) market reactions to USDA crop production reports and World Agricultural Supply and Demand Estimates (WASDE) reports over the period of 1969 through 1989.[15] The authors divided the sample into sub-periods (1969-1982; 1982-1989; and 1982-1985), to allow a comparison with the period covered in Sumner and Mueller (1989) study. In the first sub-sample, which overlaps the previous study sample, the authors find that in every case, for both commodities, the absolute price change following a report is greater than on non-report days, consistent with the previous study results. In the

[13] The authors empirical approach uses a relative and absolute closing price change and a variance of the relative price change variables and various *t-tests, F-tests,* and nonparametric chi-square tests to demonstrate that the null hypothesis of no significant difference between means of absolute values or variance changes in closing prices on days following a USDA release and other days is rejected.

[14] They showed that the *t-statistic* and *F-statistic* are almost highly significant for both crops in those months.

[15] Their empirical procedure is similar to the Sumner and Mueller (1989), though they divided the sample in sub-periods and included one more analysis. They employed a regression analysis, which according to the authors allowed an explicit measure of magnitude related to a report's news.

others sub-samples, their results suggest that futures markets reacted less to USDA reports release, especially after 1985, than in earlier years, which is also in line with the last suggestion presented by Sumner and Mueller (1989). Fortenbery and Sumner (1990, p. 122 and 123) concluded that based solely on *t-tests* "USDA reports no longer provide news to market", and introduced a reason for this scenario considering that perhaps "participants have become sufficiently skilled to anticipate the information forthcoming, and thus no market reaction is detected".

Garcia *et al.* (1997) examine the value of USDA production forecast and private crop forecasts on the soybean and corn futures prices using three different tests of informational content for the period between 1971 and 1992.[16] The private crop forecasts used in the analysis are prepared by Conrad Leslie and Sparks Company, Inc, both US based firms that use different sources and procedures for estimating crop size, and release their forecasts two or three days prior to the USDA reports announcements. The authors consider these two private sources "are regarded as reliable and widely-reported in the popular press" (Garcia *et al.,* 1997, p. 560). In contrast with Fortenbery and Sumner (1990), their overall results do not find any evidence supporting the declining informational value of USDA reports since the mid-1980s. They suggest that the difference between both findings is largely due to the different tests used to determine the significance of price reaction, though they consider the tests used by Fortenbery and Sumner (1990) "appear to be less powerful in detecting price reactions than the tests employed in this study" (Garcia *et al.*, 1997, p. 566), since the authors' study incorporate more information, specifically, expectations of market participants. Concerning the private forecasts, their results suggest that private market participants have substantially improved their forecasting ability relative to the USDA, especially since the mid-1980s, and that nowadays the relative forecasting accuracy of both sources is quite similar. Finally, they conducted a non-usual but noteworthy study, which demonstrated that futures traders of corn and soybean futures would be willing to pay for advance knowledge

[16] 1st a relative forecast accuracy test; 2nd a price reaction test (similar to an event study approach); and, 3rd an Willingness to pay test.

of the USDA forecasts, mainly due, as the authors' state, to the reason that USDA forecasts are perceived to be less risky than private forecasts.

Regarding the accuracy ability of private and USDA forecasts, McKenzie (2008) agrees with Garcia *et al.* (1997) findings. Notwithstanding, the author demonstrates based on a sample between 1970 and 2005 that corn and soybean futures prices continue to react to USDA reports releases, by showing that reports would improve market participants' price expectations if released a day earlier.[17] Despite this, he suggests that these reports no longer appear to provide better estimates than private forecasts.

On wheat futures market, Marone (2008) supports Fortenbery and Sumner (1990) conviction, by finding evidence that market participants have been able to anticipate at least some of the information to be released by the USDA reports. This finding results from an event study of a 10-day window around the USDA announcement day, which focus on CBOT wheat futures prices and on a sample between January 1992 and July 2008.[18] The overall result suggests that prices adjust to new information mostly on the days prior to and on the day of the release of the USDA report, which enhances the conviction that participants have become more skilled to anticipate the forthcoming information based on other sources. Moreover, by the dividing the sample into sub-samples, she finds that between 2001 and 2008 almost 95% of the 10-day wheat futures price movements occurred on the days prior to the release. Nonetheless, she is in line with on Garcia *et al.* (1997) and McKenzie (2008) point of view that, though the informational value of USDA reports have decreased over time, they still contain relevant information and should be followed by market participants.

Irwin *et al.* (2001) also refuted Fortenbery and Sumner (1990) results and recognized a new possible limitation of their study, considering the fact that they use

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[17] McKenzie (2008) used a modeling approach developed by Hamilton, that exploits co-movements in USDA corn and soybeans crop production forecasts with corn prices to uncover agents' price expectations. The author considers the Hamilton-type approach is superior to the traditional event study approach.

[18] Her study collects data on estimates of use and ending stocks of wheat from individual USDA WASDE reports for the period from January 1992 and July 2008. To her empirical study she investigated the price movements to the releases of CBOT wheat futures prices, through an event study approach, a 10-day window around the announcement day.

close-to-close returns instead of close-to-open returns. WASDE reports are released either after the close of trading (before May 1994) on the release date or before the opening of trading (May 1994 and after) on the release date. Attending to this fact, price reaction measured on a close-to-close basis "may mask the market's reaction to WASDE reports due to the added variability associated with other information that becomes available to the market during the trading day" (Irwin *et al.*, 2001, p. 6). Hence, Irwin *et al.* (2001) study is based on close-to-open returns, to best reflect the immediate reaction of futures prices. The authors' study consist of an event study with a 13-day window around WASDE reports release day to measure the relative change in CBOT corn and soybean futures prices and is based on a sample from 1985 to 1998. For both corn and soybeans and for the entire study period, their results suggest that on WASDE monthly reports that include both outlook and situation information (as previously mentioned WASDE reports from August through November plus January include NASS estimates), there is a significantly higher price variation on report release session than on pre and post-report session. [19] Moreover, their results also find that there are differences in price response during the early part (1985-89) of the sample period compared to the latter part (1990-98), being the higher price reactions recorded in the latter part.

Following Irwin *et al.* (2001), Isengildina-Massa *et al.* (2008) through a similar approach extended the sample period from 1985 to 2006. The overall results on the period not covered in the previous study, from 1999 to 2006, are quite similar and provide further evidence that the impact of WASDE reports has increased over time.[20] This last finding is in contrast with most of the studies mentioned previously (Fortenbery and Sumner, 1990; Sumner and Mueller, 1989; Marone, 2008).

More recently, Adjemian (2011) used a Generalized Least Square model to quantify the WASDE report announcement effect for cotton, soybean and wheat futures from 1980 through 2010. He founds consistent results with prior research and

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[19] Their results figure that return variance on report sessions is 6.15 times greater than normal return variance in corn and 6.14 times greater than normal variance in soybean futures (WASDE plus NASS reports).

[20] Return variance on the sub-period 1990-95 report sessions is 5.70 times greater than normal return variance in corn and 6.53 times greater than normal variance in soybean futures. While, in the sub-period 1996-2006, return variance on report sessions is 10.67 times greater than normal return variance in corn and 9.3 times greater than normal variance in soybean futures (WASDE plus NASS reports).

concludes that WASDE reports contain important information. More precisely, he showed that the publication of WASDE report "is followed by an immediate reaction reflected in the opening futures price for each commodity" (Adjemian, 2011, p. 255) and also that, as Irwin *et al.* (2001) and Isengildina-Massa *et al.* (2008) demonstrated, the report is more important to the market in certain months, specifically in the ones that the NASS crop production forecasts are included. Furthermore, the noteworthy contribution of this research is that it quantifies the announcement effect on the value of each commodity contract. For instance, the author shows that "the overnight returns on soybean contracts are estimated to respond to WASDE by 0.23%, amounting to a shock of $77 per contract at the mean price level of $6.69 per bushel, since each contract represents 5,000 bushels" (Adjemian, 2011, p. 251).

Finally, Lehecka (2013) covers the most recent empirical evidence. However, his study focuses solely on the impact of USDA Crop Progress and Condition Info reports.[21] The authors' study employs an event study methodology, similar to Irwin *et al.* (2001), on corn and soybeans futures contracts over the period 1986 to 2012. The study corroborates previous studies, but furthers light by demonstrating that markets react to USDA specific reports (Crop Progress and Condition Info), which means that those reports provide valuable information to corn and soybean futures markets. Additionally, Lehecka (2013) finds, in accordance with Irwin *et al.* (2001) and Isengildina-Massa *et al.* (2008) findings, an increasing of market reactions to the reports over time. Particularly in the sub-sample from 1996 through 2012, they find the strongest reaction, for which they argue as a cause the higher uncertainty regarding future market conditions.

Given the unambiguous causal relationship for the dynamics in agricultural commodities futures prices recorded over the last decade, the ongoing debates over the importance and value of USDA reports, and the traditional importance of USDA WASDE reports, the following empirical analysis has the purpose to investigate the impact and value of WASDE reports in the major agricultural commodities futures

[21] USDA Crop Reports are "issued weekly during the growing season, listing planting, fruiting, and harvesting progress and overall condition of selected crops in major producing states". While conditional info, "represents direct assessments of the overall status of a crop throughout the growing season" (Lehecka, 2013, p. 11).

traded in the US and European markets over the period January 1998 through December 2012.

Although there is a vast amount of research over this topic for US major agricultural commodities, since 2006, when the highest volatility period in history experienced began, there are only few studies that investigate WASDE reports impacts. Moreover, this study sheds light on measuring the impact of WASDE reports over European agricultural commodities futures market. Since WASDE reports have an international scope, there should be expected price reactions on European commodities futures markets after the announcements.

3. Sample & Methodology

The empirical analysis used in this study follows previous studies procedures and assumptions (Irwin *et al.,* 2001; Isengildina-Massa *et al.,* 2008; Fortenbery and Sumner, 1990; Sumner and Mueller, 1989; Lehecka, 2013).

The main focus of this analysis consists on measuring the price reaction of USDA WASDE reports release in the major agricultural commodities futures contracts traded in the US and Europe. For that, it is used an Event Study approach similar to the one employed by Isengildina-Massa *et al.* (2008) and Irwin *et al.* (2001).

3.1. Data

3.1.1. Event Study Data

The "events" analyzed include the release of all USDA WASDE reports for wheat, corn and soybeans (CBOT and NYSE Euronext Liffe) over the period from 1998 through 2012. Since WASDE reports are monthly released, a total of 180 WASDE reports were released during this time period. Notwithstanding revisions to WASDE reports being released from time to time, only original reports are considered (similar to Adjemian, 2011). Throughout the covered period, the majority of reports were released on the scheduled time, between the 9th and 12th of the month (93%), and released at 8:30 am Eastern Time, before the daytime trading session in the US (CBOT) and during the daytime trading in Europe (Euronext).[22]

The sample period between January 1998 and December 2012 intends to cover the period where agricultural futures price reached historical highs and when markets experienced drastic events.

Following Irwin *et al.* (2001), Isengildina-Massa *et al.* (2008) and Fortenbery and Sumner (1990) procedure, WASDE reports during the sample period are divided into two groups. The first group represents "pure" outlook information and includes the WASDE releases during December and February through July. The second group represents a "mix" of situation and outlook information and includes WASDE

[22] The WASDE releases started being issued in January 2013 at 12 pm Eastern Time.

releases during August through November and January, when WASDE reports include NASS crop production estimates. This "WASDE and NASS" group, as Isengildina-Massa *et al.* (2008) named, includes US situation information (NASS production estimates for the US), international situation crops information, provided by Foreign Agricultural Service (FAS) production estimates for non-US countries, and domestic and international outlook information (WASDE regular information: consumption, ending stocks, and price forecasts for the US and non-US countries).

Concerning the event window, it comprises 11 trading days, and is divided as follows: 5 days before the WASDE release, the "event" day, and 5 days after the release. This event window is intended to measure price reactions before, during and after the WASDE release.

3.1.2. Futures Market Data

Wheat, corn and soybeans futures prices for CBOT and corn and wheat futures prices for NYSE Euronext Liffe contracts nearest-to-maturity, but maturing in the calendar month after a given release month, are collected for 5 days before the release of each WASDE report, the day of release and 5 days after the release of each WASDE report, or a total of 11 days for each release (Irwin *et al.,* 2001, p. 4) over the January 1998 through December 2012 sample period. Specific CBOT and NYSE Euronext futures maturity matched to each WASDE release are presented in Table 2.

Table 2 - Futures Contracts Used in the Event Studies

WASDE Release Month	Nearest to Maturity Futures Contract				
	CBOT			NYSE Euronext Liffe	
	Corn	Soybeans	Wheat	Corn	Wheat
January	March	March	March	March	March
February	March	March	March	March	March
March	May	May	May	June	May
April	May	May	May	June	May
May	July	July	July	June	November
June	July	July	July	August	November
July	September	August	September	August	November
August	September	September	September	November	November
September	December	November	December	November	November
October	December	November	December	November	January
November	December	January	December	January	January
December	March	January	March	January	January

Note: Contracts refer to Chicago of Boar of Trade (CBOT) and NYSE Euronext Liffe futures contracts
Source: NYSE Euronext Liffe Commodity Derivatives; CBOT; USDA World Agricultural Outlook Board.

Following Irwin *et al.* (2001) and Isengildina-Massa *et al.* (2008), the nearest-to-maturity futures contracts are selected for two reasons. First, nearest-to-maturity futures contracts typically are the most heavily traded contracts and, hence, the most liquid contracts. Second, as the referred authors argue, the nearest-to-maturity futures contracts for storable commodities generally reflect the price impact of both old and new crop information. For these reasons, it seems reasonable to consider "that the best measurement of price impact can be derived from nearest-to-maturity contracts for each release" (Isengildina-Massa *et al.,* 2008, p. 92).

Daily opening and settlement prices for each commodity and for the sample period covered were collected from Datastream database (Thomson Reuters). The futures selected follow a continuous series or perpetual series of futures prices methodology, which is a Thomson Reuters calculated time series available on Datastream products. The futures continuous series methodology start at the nearest available contract month, which forms the first value for the continuous series until either the contract reaches its expiry date or until the first business day of the notional contract month, whichever is sooner. At that point prices from the next trading contract month are taken and no adjustments are made for price differentials. In other words, the continuous series uses the futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires. This continuous series of Datastream roll method that covers all possible contract months trading is called "Type CS00" (Thomson Reuters, 2010).

Table 3 - Datastream Continuous Futures Details

Name	DS Mnemonic	Market	Exchange	Trade Since
CBT-Corn Continuous	CC.CS00	US	eCBOT	4-Jan-1979
CBT-Wheat Continuous	CW.CS00	US	eCBOT	5-Jan-1978
CBT-Soybeans Continuous	CS.CS00	US	eCBOT	2-Jan-1979
LIFFE-Wheat Continuous	LWH.CS00	UK	Euronext Liffe London	3-Oct-1989
MATIF-Corn Continuous	PCO.CS00	France	Euronext Paris MATIF	1-Oct-1999

Source: Datastream (Thomson Reuters).
Notes: The Mnemonic symbology is the commodity symbol plus the roll type and trading cycle (CS00).

An important issue and a potential constraint in event studies on agricultural futures markets is the presence of price limits.[23] Price limits restrict daily futures price movements, and thus may prevent prices from reflecting the full impact of new information contained in a WASDE report (Irwin *et. al.,* 2001). As a result, price limits may bias estimates of price reactions (Lehecka, 2013). Nevertheless, previous studies found evidence that price limits are unlikely to "bias market reaction tests substantially" (Isengildina-Massa *et al.,* 2008, p. 93). Thus, following Sumner and Mueller (1989), Fortenbery and Sumner (1990), Irwin *et al.* (2001), Isengildina-Massa *et al.* (2008) and Lehecka (2013), there are not made any adjustments on the agricultural futures price data to account for price limits in this study.

Previous studies also indicate that a higher variability of close-to-open returns persists more over the weekend than over other days of the week, which may bias market impact tests (event studies) if WASDE reports are released on Monday's (Lehecka, 2013; Isengildina-Massa *et al.,* 2008). However, in the sample period, only 12 (7%) WASDE reports returns were weekend returns (i.e. released on Monday's). Isengildina-Massa *et al.* (2008) excluded weekend returns from their sample and concluded that, although it marginally increased the size of test statistics, the hypothesis test conclusions remained unchanged. Moreover, Irwin *et al.* (2001) on their event study do not omit any weekend returns. In this empirical analysis weekend returns are not excluded from the sample. Nonetheless, for the event window days (-5;…; +5) are only included in the sample weekdays returns for which markets were open. In other words, weekends are excluded and only Friday-Monday returns are part of the sample.

3.2. Model and Methodology

Following the insight and practice of Irwin *et al.* (2001) and Isengildina-Massa *et al.* (2008), this analysis uses a variant of the event study methodology: the mean

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[23] For instance, according to the current to the CBOT current daily price limits, the daily price limit for CBOT corn and wheat contracts is set at $0.60/bushel.

price reaction tests.[24] This variant is based on the notion that the information may affect the mean (price level) of the expected distribution of futures prices (McNew and Espinosa, 1994). Also, both parametric and nonparametric statistical tests are used to determine the significance of mean price reaction to the release of USDA WASDE reports.

3.2.1. Mean Price Reaction Tests

Following Isengildina-Massa *et al.* (2008, p. 6), the mainline of testing mean price reaction is to verify whether the variability of wheat, soybeans and corn (for CBOT and Euronext) prices immediately after the release of WASDE reports is larger than "normal". This methodology is in line with the overall event studies approaches, since it assumes that in an efficient market, price variability significantly larger than normal indicates that reports contain valuable new information. The same authors consider that "testing this hypothesis requires careful definition of the measure of normal variability and the measure of variability immediately after the release of WASDE reports".

To begin the tests description, which is similar to the one employed in Irwin *et al.* (2001) and Isengildina-Massa *et al.* (2008) empirical analysis, a time index (t) and an event index (i) are needed. The time index, or in other words the even window length, is t = -5,…, -1, 0, +1,…, +5, where:

- t = 0 indicates the daytime trading session at the CBOT or Euronext (hereafter, the "session") immediately after the WASDE report release – the "event" day;
- t = -5,….., -1 indicates the sessions before the given release (henceforth, "pre-report sessions"; and,
- t = +1,..., +5 indicates the sessions after the release (henceforward, "post-report sessions").

Concerning the event index, which is the number of releases in the sample period, i = 1,..., 180, with one indicating the first WASDE release in the sample period (13th of January of 1998) and 180 indicating the last release (12th of December of 2012).

[24] According to MacKinlay (1997), event studies have a long history and the first published study belongs to James Dolley (1933), where the author examined the price effects of stock splits from 1921 to 1931.

As previously referred, the Efficient Market Hypothesis (EMH) suggests that, as new fundamental information becomes available (in USDA releases), future prices should immediately adjust to the "news". Since WASDE reports are released before the opening of trading on the release date in the US, this means that in CBOT futures market if the reports contain any valuable information, it should be reflected instantaneously in future price as soon as a trading session opens (McKenzie, 2008). Thus, in CBOT close-to-open price changes will best reflect the immediate impact of wheat, corn and soybeans futures prices (Isengildina-Massa *et al.,* 2008). Whereas, in Euronext futures markets the WASDE report release occurs in the middle of the trading session day (the "event day"), precisely at 3:30 pm Paris time and 2:30 pm London time. Hence, the price reaction for Euronext Liffe Paris corn and for Euronext Liffe London wheat will be based on open-to-close measures of futures price changes.

In order to account for differences in the level of prices over the sample period, two measures of the relative change in futures prices are used in the mean price reaction tests: the relative and absolute changes in futures prices. For CBOT wheat, corn and soybeans, the raw close-to-open return for a given WASDE release is computed as follows,

(1) $$r^0_{t,i} = \ln(p^0_{t,i} / p^c_{t-1,i}) \cdot 100 \qquad t = -5,\ldots..,0,\ldots.,+5$$

where, $p^0_{t,i}$ is the opening price of the nearest to maturity CBOT wheat, corn and soybeans futures contract for session t and event i and $p^c_{t-1,I}$ is the closing price of the nearest to maturity CBOT wheat, corn and soybeans futures contract for session *t-1* and event i. The absolute close-to-open is computed in the following way,

(2) $$|r^0_{t,i}| = |\ln(p^0_{t,i} / p^c_{t-1,i}) \cdot 100| \qquad t = -5,\ldots..,0,\ldots.,+5$$

For Euronext corn and wheat, returns are computed on open-to-close basis,

(3) $$r^c_{t,i} = \ln(p^c_{t,i} / p^0_{t,i}) \cdot 100 \qquad t = -5,\ldots..,0,\ldots.,+5$$

where, $p^c_{t,i}$ is the closing price of the nearest to maturity Euronext corn and wheat futures contract for session t and event i and $p^0_{t,i}$ is the opening price of the nearest to maturity Euronext corn and wheat futures contract for session t and event i.

The absolute open-to-close is computed as follows,

(4) $$|r^c_{t,i}| = |\ln(p^c_{t,i} / p^0_{t,i}) \cdot 100| \qquad t = -5,\ldots,0,\ldots,+5$$

with the same definitions as for equation (3).

To determine if WASDE reports change futures market participants mean price expectations, two statistical tests are used. The null hypothesis for both statistical tests employed is that return variability for report sessions and pre-report and post-reports return sessions is equal, this means no difference occurs between release days and the other days (Irwin *et al.,* 2001; Sumner and Mueller, 1989). Each test requires the specification of a measure of variability for the period immediately following the WASDE reports release and for a period of "normal" variability. In other words, for each test is necessary to establish a baseline, typically called in event study analysis the "normal return", to compare the returns (% price changes) on the event date (McKenzie, 2008). For each test, variability for the period immediately following the release of WASDE reports is based on session 0 returns (henceforth, report return). Similar to Sumner and Mueller (1989), Fortenbery and Sumner (1990) and Isengildina-Massa *et al.* (2008), normal variability is based on the 5 sessions previous to the release (hereafter, pre-report returns) and the 5 sessions after release (henceforward, post-report returns). Note that tests are specified on a close-to-open basis for CBOT wheat, corn and soybeans futures and on a close-to-close basis for Euronext corn and wheat.

The first test suggested by Isengildina-Massa *et al.* (2008) and is a conventional *F*-test of the ratio of the variance for raw report returns to the variance for raw pre- and post-report returns. The raw close-to-open variance for report returns is computed as follows,

(5) $$\sigma^2_R = \frac{1}{N-1} \sum_{i=1}^{N} (r^0_{0,i} - \overline{r^o_R})^2 \qquad t \neq 0$$

where N is the total number of WASDE report releases included in the estimation, $\boldsymbol{r^{0}_{0,i}}$ is the raw close-to-open report return for the i^{th} release and $\overline{\boldsymbol{r^{o}_{R}}}$ is the estimate of the mean raw close-to-open report returns across the N releases. The raw close-to-open variance for pre and post-report returns is computed as,

(6) $$\sigma^2{}_R = \frac{1}{N*10-1*N} \sum_{i=1}^{N} \sum_{t=-5}^{+5} (r^{0}_{t,i} - \overline{r^{o}_{NR}})^2 \qquad t \neq 0$$

where N is the total number of WASDE report releases included in the estimation, $r^{0}_{t,i}$ is the t^{th} raw close-to-open pre or post-release return for the i^{th} report and $\overline{r^{o}_{NR}}$ is the estimate of the mean of raw close-to-open returns across the $N \cdot 10$ pre and post release returns. The F-statistic is computed as follows,

(7) $$F = \frac{\sigma^2_R}{\sigma^2_{NR}}$$

where the sampling distribution of the F-statistic under the null hypothesis of equal variances follows and F distribution (Isengildina-Massa *et al.* 2008, p. 8).

For open-to-close returns, simply substitute close-to-open returns ($\boldsymbol{r^{0}_{0,i}}$) for open-to-close returns ($\boldsymbol{r^{c}_{0,i}}$). The equation for the raw open-to-close variance for report returns,

(8) $$\sigma^2{}_R = \frac{1}{N-1} \sum_{i=1}^{N} (r^{c}_{0,i} - \overline{r^{c}_{R}})^2 \qquad t \neq 0$$

And for the raw open-to-close variance for pre and post-report returns as follows,

(9) $$\sigma^2{}_R = \frac{1}{N*10-1*N} \sum_{i=1}^{N} \sum_{t=-5}^{+5} (r^{c}_{t,i} - \overline{r^{c}_{NR}})^2 \qquad t \neq 0$$

with the same definitions for equation (8) and (9) as for equation (5) and (6), just changing: the close-to-open returns $\boldsymbol{r^{0}_{0,i}}$ in equation (8) for the open-to-close returns $\boldsymbol{r^{c}_{0,i}}$ and in equation (9) the close-to-open returns $\boldsymbol{r^{0}_{t,i}}$ for the close to close returns $\boldsymbol{r^{c}_{t,i}}$ and the estimate $\overline{\boldsymbol{r^{o}_{NR}}}$ for $\overline{\boldsymbol{r^{c}_{NR}}}$.

The second test performed is the Kruskal-Wallis X^2 test, a nonparametric test applied to absolute returns that do not rely on the assumption of normality. This test is used to insure that results are not sensitive to test selection and to control and sustain the results of the first parametric test (Lehecka, 2013; Isengildina-Massa *et al.* 2008).

3.2.2. WASDE Release Impact in Context

To measure the market-level impact of WASDE releases on the holder of each futures contracts positions, measured in terms of the maintenance margin, a similar approach to the one introduced by Adjemian (2011) is employed, which has been previously referred. [25] In this approach and as a practice in futures markets, the maintenance margin, the posted collateral by each market participant, is compared with the positions profits and losses and thus allows to judge the futures' performance relative to other opportunities. Adjemian (2011, p. 250) claims that evaluating the WASDE releases effect in this way is a "useful method to ascertain how the report affects market participants".

[25] According to Adjemian (2011, p. 249), the maintenance margin "is the amount of collateral a market participant must deposit within an exchange in order to keep one futures contract position open".

4. Empirical Results

4.1. Descriptive Statistics

Table 4 presents descriptive statistics for CBOT soybeans, wheat and corn close-to-open returns and Euronext Wheat and Corn Open-to-Close returns from 1998 through 2012. The statistics were computed by combining all the WASDE release session returns and pre and post-report sessions returns. The means for all commodities are quite small and insignificantly different from zero. On the other hand, the means of the absolute returns are statistically significant, reflecting the variability in price movements (Lehecka, 2013). Significant skewness and kurtosis are identified in all series of commodities, which indicates that the distribution might not be normal. This suspicion is verified by the Jarque-Bera and Shapiro-Wilk normality tests since both reject the null-hypothesis of normality in all cases. Nonetheless, this finding is not surprising and is consistent with the analysis of agricultural futures prices data done by others (Sumner and Mueller, 1989; Lehecka, 2013), which assume that "non-normality is a well-known distributional characteristic of agricultural future returns" (Isengildina-Massa *et al.*, 2008, p. 95).

Table 4 - Descriptive Statistics for CBOT and Euronext Commodities, 1998-2012

	CBOT						Euronext			
	Soybeans		Wheat		Corn		Wheat		Corn	
	r	|*r*|	*r*	|*r*|	*r*	|*r*|	*r*	|*r*|	*r*	|*r*|
Mean	0.01	0.68	0.03	0.75	-0.01	0.78	-0.03	0.59	0.07	0.64
Std. Deviation	1.06	0.81	1.13	0.84	1.24	0.96	0.89	0.67	0.90	0.83
Variance	1.11	0.65	1.27	0.71	1.54	0.92	0,80	0.45	0.81	0.69
Min	-1.74	0.00	-5.83	0.00	-6.72	0.00	-6.37	0.00	-7.97	0.00
1st Quartile	-0.43	0.19	-0.51	0.19	-0.54	0.22	-0.45	0.14	-0.19	0.16
Median	0.00	0.44	0.00	0.50	0.00	0.52	0.00	040	0.00	0.38
3rd Quartile	0.45	0.88	0.48	1.02	0.49	1.01	0.36	0.82	0.35	0.85
Max	11.16	11.16	10.54	10,54	16.85	16.85	7.59	7.59	6.89	8.09
Skewness (a)	0.46	3.76	1.07	3.20	1.54	4.63	0.35	2.77	-0.32	3.05
Kurtosis (b)	12.90	26.25	9.23	19.67	22.35	47.73	7.37	14.61	13.88	15.14
Jarque-Bera (c)	8,159	49,255	3,578	26,304	31,690	172,126	1,619	13,653	8,654	13,456
Shapiro-Wilk	0.88	0.69	0.90	0.73	0.86	0.67	0.92	0.76	0.82	0.70
Count	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,980	1,748	1,748

Note: Returns are computed as the difference Close-to-Open (CBOT) and Open-to-Close (Euronext) in natural logarithm prices multiplied by 100. Number of observations is 1980 for CBOT crops and for Euronext wheat. *N* for Corn Euronext is 1,748, since futures contract were only introduced in October 1999. **(a)** The absolute value of Skewness is more than twice its standard error (1,78) for most commodities, which indicate that the data might not be symmetric, and therefore not normal. **(b)** Similarly, the absolute value of kurtosis is more than twice its standard error for most commodities and this is also an indication that the data are not normal. **(c)** The Jarque-Bera test, a normality test, rejects normality in all cases significant at a 1% level. The Shapiro-Wilk test also tests normality and rejects for the all series the normality hypothesis (significant at a 5% level).

4.2. Empirical Results for Mean Price Reaction Tests

The impact of WASDE reports releases is first demonstrated graphically. The following figures display the return variance of each commodity covered in this study for the 10 trading sessions around all WASDE releases from January 1998 to December 2012. At a first glance, it is clearly notable a difference between exchange markets variability (CBOT and Euronext). In CBOT commodities, the return variance on WASDE release sessions is about 4 times the level of return variance on other days in the event window, indicating that WASDE reports have a large impact on soybeans, wheat and corn futures markets traded on CBOT. Whereas, return variance verified in the commodities traded on Euronext, despite being higher on WASDE report days, there is not perceptible any pattern across the all sample, so this might suggest that WASDE reports have no impact on European futures markets.

Figure 5 - CBOT Soybeans

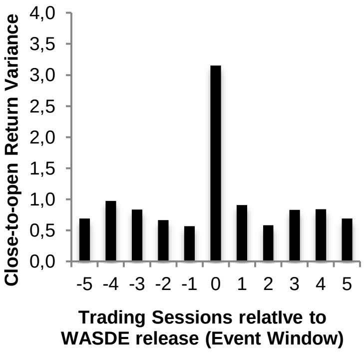

Figure 6 - CBOT Soybeans

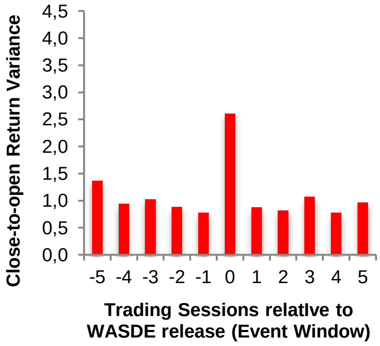

Figure 7 - CBOT Corn

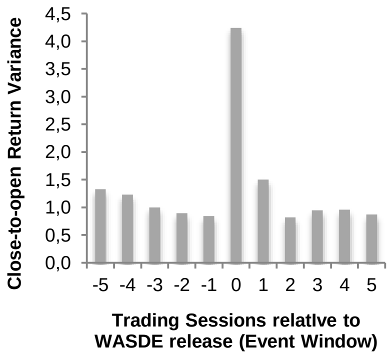

Figure 8 - Euronext Wheat

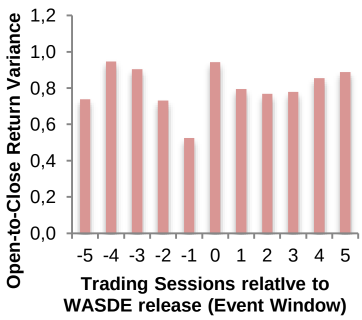

Figure 9 - Euronext Corn

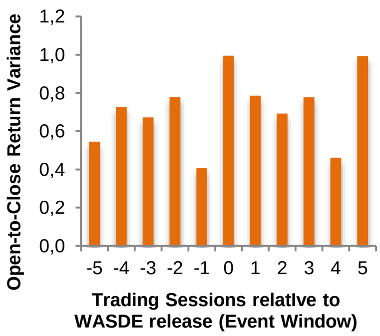

Table 5 presents the empirical analysis main results for CBOT commodities on the variability of report days and pre and post-report days for the entire sample period, from January 1998 through December 2012. Return variance on WASDE report release sessions (the "event" day) across all months is 3.76 greater than pre and post return variance for soybeans, 2.48 times greater for wheat and 3.69 times greater for corn (*F*-test results). Both, the parametric and non-parametric statistical tests show that the increase in return variability on report session days is consistently significant for soybeans, wheat and corn at the 1% level. These results indicate that the information contained and released in WASDE reports in general change the expectations and reduce the uncertainty of CBOT futures market participants regarding the subsequent distribution of futures prices or spot prices.

For the "mix" group that includes WASDE and NASS reports and contains both the domestic and international crops information and the outlook information, Table 5 demonstrates that there was substantially larger price variability on report release session days than on pre and post report sessions - return variance on report session days was 7.02 times greater than pre and post report session variance for soybeans, 4.12 times greater for wheat and 7.03 times greater for corn. The increase in return variability on report days is significant at the 1% level. These results are consistent with previous research (Isengildina-Massa *et al.*, 2008; Fortenbery and Sumner, 1990, Irwin *et al.,* 2001), thus and as they concluded for previous sample periods, the WASDE and NASS reports group clearly demonstrates to has more impact on futures return variance and its release causes considerable larger changes on future market participants expectations.

On the other hand, for the "pure" group that includes only the WASDE reports months, Table 5 indicates small impacts compared to the "mix" group months. Report session variance for soybeans is lower than pre and post-report session variance for WASDE only months, which is confirmed with the non-rejection of the null hypothesis of return variability for report sessions and pre-report and post-reports return sessions being equal. In wheat futures, report session variance is 1.09 times greater for WASDE only months, but this increase is only significant for the non-parametric statistical test. In corn, report session is 1.38 times higher and

Table 5 - CBOT Futures Return Volatility Test for WASDE reports, 1998-2012

		Soybeans Futures					Wheat Futures					Corn Futures				
Report Group	***N***	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X^2* Test**	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X^2* Test**	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X^2* Test**
All Months	180	3.15	0.84	2.32	3.76***	24.96***	2.61	1.05	1.56	2.48***	21.10***	4.25	1.15	3.10	3.69***	29.71***
WASDE and NASS	75	6.68	0.95	5.73	7.02***	16.73***	4.84	1.18	3.66	4.12***	23.69***	8.03	1.14	6.89	7.03***	55.06***
WASDE	105	0.68	0.76	-0.08	0.89	1.15	1.05	0.97	0.09	1.09	13.65***	1.59	1.16	0.44	138***	4.94*
January	15	6.75	0.51	6.25	13.36***	22.51***	7.01	0.78	6.23	8.97***	10.55***	16.00	0.99	15.01	16.23***	23.85***
February	15	0.74	0.43	0.31	1.73*	0.95	1.02	0.69	0.33	1.48*	4.72*	1.39	0.34	1.05	4.07***	2.96
March	15	0.67	079	-0.12	0.84	0.77	0.91	1.28	-0.37	0.71	2.27	0.82	0.93	-0.11	0.88	1.11
April	15	0.74	0.35	0.40	2.14**	5.12*	0.88	0.69	0.19	1.28	0.61	0.78	1.00	-0.22	0.78	1.86
May	15	1.42	0.55	0.87	2.59***	8.11**	1.17	0.79	0.38	1.48	3.91	4.76	0.83	3.93	5.71***	11.69***
June	15	0.18	0.84	-0.66	0.21	1.39	1.90	0.82	1.08	2.33***	4.93*	2.18	1.17	1.01	1.86***	0.89
July	15	0.88	1.81	-0.93	0.49	2.35	1.42	1.74	-0.32	0.82	0.24	1.70	2.94	-1.25	0.58	3.22
August	15	8.57	1.51	7.06	5.68***	4.71*	6.27	1.68	4.59	3.73***	8.91**	9.48	1.39	8.10	6.84***	20.61***
September	15	3.56	0.79	2.77	4.52***	5.89*	1.76	1.08	0.68	1.63*	0.16	3.05	0.75	2.30	4.06***	3.14
October	15	1.27	1.22	12.04	10.84***	12.24***	8.28	1.52	6.75	5.44***	8.66**	12.22	1.74	10.48	7.04***	7.15**
November	15	3.14	0.73	2.41	4.31***	4.37	2.28	0.82	1.46	2.77***	4.66*	1.70	0.85	0.85	2.00**	6.17**
December	15	0.40	0.54	-0.14	0.75	1.14	0.53	0.76	-0.23	0.70	0.86	0.22	0.87	-0.65	0.25	2.86

Note: Returns are computed as the difference close-to-open in natural logarithm prices multiplied by 100. *N* denotes the number of WASDE reports released. Continuous futures contract are used: a Datastream methodology - futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires). (*) indicates significance at the 10% level. (**) denotes significance at the 5% level. (***) indicates significance at the 1% level. The WASDE and NASS group include releases during August through November and January. Report Sessions Variance is function (5); Pre-Post Report Sessions Variance is function (6); *F*-Statistic is function (7); Kruskal- Wallis X^2 is the non-parametric test. The WASDE group includes releases WASDE releases in December and from February through July.

both statistical tests indicate that increase is significant. Therefore, one could assert that the evidence is mixed in what concerns the significance of market impact for the WASDE only group of reports, though test results clearly evidence that the impact is smaller compared to the impact of WASDE and NASS group of reports.

Concerning the monthly impact of WASDE reports, the release impact for individual calendar months was analyzed. Table 5 presents consistence evidence (both parametric and non-parametric statistical tests are significant at least at a 10% level) of market reactions to the WASDE and NASS reports released in January, August and October for soybeans, wheat and corn futures across the all sample period. For WASDE only months is only found consistent evidence (both statistical tests are significant for both commodities) of an increase in report return variance for soybeans and corn in May. For wheat, the WASDE only month for which the report variance increase appears to be statistically significant is in June. Furthermore, and once again, results denote that the WASDE and NASS reports group has a higher impact on the variability of CBOT futures returns. In detail, for the all sample period, the largest relative impact of reports is evident on January and October. Return variance on January report sessions is 13.26 times greater than pre and post return variance for soybeans, 8.97 times higher in wheat and 16.23 times greatest in corn futures. In October report sessions, the joint monthly return variance is 10.84 times greater than pre and post report return variance for soybeans, 5.44 times higher in wheat and 7.04 greater in corn.

Attending that the US major agricultural commodities are planted between August and October and harvested between May and July, the previous results are not surprising. For the WASDE only report months, a smaller market impact is verified due to the lower uncertainty regarding agricultural crop and market conditions in those months. However, in December uncertainty should remain higher, though the results show a low market impact to reports release. Thus, this means that the NASS crop production reports have a considerably higher informational value for market participants.

Those were the results for CBOT commodities, in which it is possible to conclude, based on the test results presented, that reports have significant impact on soybeans, wheat and corn futures return variance. Concerning the Euronext wheat and corn futures, a similar approach to test the impact of WASDE reports on return variance was followed, though returns are based on a Open-to-Close basis, and are presented in Table 6.

As previously asserted, test results in Table 6 evidence that WASDE reports have a small impact on Euronext wheat and corn futures return variance in most of the cases. In the overall months, though the report session variance is 1.08 for wheat and 1.30 for corn times higher than pre and post-report variance, there is only marginal evidence for corn (only *F*-test is significant and at a 10% level).

Furthermore, in wheat futures traded on Euronext it is not verified any consistent evidence for the all tests results. Nevertheless, the marginal evidence (only significant results in *F*-tests) of an increase in report return variance suggest a similar pattern as the one denoted in CBOT commodities:

- WASDE and NASS reports months group has higher impact on the variability of wheat futures returns: report session variance is 1.76 times higher than pre and post report variance;

- January and October WASDE and NASS reports release represent the months with the highest market reaction: report session variance is 2.37 and 3.82 times greater, respectively for January and October reports, than pre and post report variance.

Concerning Euronext corn futures, Table 6 presents consistent evidence of market reactions for WASDE and NASS months and for the individual calendar month of January. Additionally, it is found a marginal evidence of an increase in report return variance in October. Therefore, these results also suggest a similar pattern as CBOT commodities show.

The previous results may look surprising, because the NASS crop production reports only includes information concerning the US major agricultural commodities. Nonetheless, the release months of WASDE and NASS reports are the ones where uncertainty regarding crop and market conditions is higher for European agricultural commodities as well.

Table 6 - Euronext Futures Return Volatility Test for WASDE reports, 1998-2012

	Wheat Futures						Corn Futures					
Report Group	***N***	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*-Statistic**	**Kruskal - Wallis *X^2* Test**	***N***	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*-Statistic**	**Kruskal - Wallis *X^2* Test**
All Months	180	0.95	0.88	0.07	1.08	1.66	159	0.98	0.75	0.23	1.30*	2.13
WASDE and NASS	75	1.61	0.91	0.69	1.76***	2.42	67	1.89	0.88	1.01	2.15***	6.06**
WASDE	105	0.49	0.85	-0.36	0.57	5.06*	92	0.33	0.66	-0.33	0.50	0.77
January	15	1.54	0.65	0.89	2.37***	3.82	13	3.44	0.40	3.04	8.69***	9.15**
February	15	0.32	0.81	-0.49	0.39	2.37	13	0.31	0.34	-0.03	0.91	0.68
March	15	0.29	0.98	-0.69	0.29	6.24**	13	0.17	1.15	-0.98	0.15	1.56
April	15	0.18	0.78	-0.61	0.23	8.09**	13	0.33	0.36	-0.03	0.91	0.19
May	15	0.65	0.98	-0.33	0.66	1.58	13	0.50	0.27	0.24	1.90	0.49
June	15	1.30	1.14	0.16	1.14	5.38*	13	0.35	0.82	-0.47	0.43	1.53
July	15	0.45	0.72	-0.27	0.62	2.05	13	0.77	1.18	-0.41	0.65	2.36
August	15	0.35	1.01	-0.66	0.35	0.47	13	1.55	1.28	0.27	1.21	2.32
September	15	0.40	0.92	-0.52	0.43	0.29	13	1.11	0.96	0.15	1.16	0.76
October	15	5.61	1.47	4.15	3.82***	3.07	14	3.78	1.31	2.47	2.88***	3.37
November	15	0.51	0.50	0.01	1.03	1.06	14	0.18	0.44	-0.25	0.42	5.19*
December	15	0.53	0.56	-0.04	0.93	0.25	14	0.07	0.55	-0.48	0.13	4.09

Note: Returns are computed as the difference Open-to-Close in natural logarithm prices multiplied by 100. *N* denotes the number of WASDE reports released. Continuous futures contract are used: a Datastream methodology - futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires).
(*) indicates significance at the 10% level. (**) denotes significance at the 5% level. (***) indicates significance at the 1% level. The WASDE and NASS group includes releases during August through November and January. Report Sessions Variance is function (8); Pre-Post Report Sessions Variance is function (9); *F*-Statistic is function (7); Kruskal- Wallis X^2 is the non-parametric test. The WASDE group includes releases WASDE releases in December and from February through July.

Overall, reports session variance in both Euronext commodities in comparison to the impact of reports in CBOT commodities is substantially smaller. Consequently, the Euronext results suggest that, especially for wheat, WASDE reports might not contain extremely valuable information concerning European commodities crops to change market participants' expectations.

Finally, concerning return variance analyses, WASDE releases impacts are examined in subsamples periods. Previous studies on agricultural commodities futures (Lehecka, 2013, Isengildina-Massa *et al.*, 2008) suggest that the impact of markets to WASDE reports may vary over time due to changing in market conditions and the implementation of different agricultural governments policies (e.g. in the middle of the last decade the government incentives/subsidies to produce biofuels from cereals). Therefore, to have into account whether WASDE reports changes depend on these factors, the entire sample is divided into five subsamples: January 1998-December 2001; January 2002-December 2005; January 2006-December 2007; January 2008-December 2010; and January 2011-December 2012. The subsample split intends to cover independently the years in which there were drastic changes in market conditions due to known events.

The first and second sub period are partly characterized by: increased market orientation of farm programs due to the 1996 and 2002 Farm Bills; the equity market bubble (dotcom crash); and, also the growing acceptance of the notion that "commodities as an asset class are a quasi-natural hedge against positions in equity markets" (Flassbeck *et al.,* 2011, p. 13). In the third sub period, small year-to-year world carry-over grain stocks were registered, hence there was more uncertainty regarding future market conditions (Isengildina Massa *et al.*, 2008).[26] This pattern was present in all the following sub-periods, with the exception of 2009 and 2012. More recently, in the last two sub periods, drastic events occurred, as the subprime crisis and the deepest economic recession, which changed agricultural commodities

[26] Carry-over grain stocks is the amount left in the bin when the new harvest begins – end of season stock. For instance, the world cereals end of season stocks in 2005/06 was 469 million tons and in 2007/08 was 405 million tons. After an increase of stocks in 2009 to a total of 512 million tons, they decreased to 497 million tons in 2013 (FAO).

futures exchange markets activity and conditions in several ways (more market participants, more volatility, etc.).

Results for the five-subsample periods in CBOT commodities are presented in Table 7. The subsamples results evidence some differences compared to overall sample results.

For the first and second subsample, it is apparent an increase in the value of WASDE and NASS reports on market participants expectations. For example, the ratio of report and pre and post-report variance for WASDE and NASS months in corn increases from 8.95 to 17.69 for the earliest and latest sub-period, respectively.

In contrast with the previous subsamples, the following two sub-periods (2006/07-2008/09) results are considerably smaller and only persists consistent evidence in both periods for corn. Considering that these periods were remarked with unprecedented price volatility, with the largest inflow of money into agricultural commodities futures in history, and also that a new market participant, index traders, came to play a major role (in terms of market share), these results suggest that WASDE reports contained significantly less valuable information to change substantially market participants expectations. Nonetheless, since index traders and the majority of speculators positions in futures markets only attempt to profit from price changes without relying on fundamentals information (e.g. WASDE releases), one could suggest that it was due to their growing presence that market conditions changed substantially. Consequently, WASDE reports might contained valuable information concerning agricultural crops and may have changed expectations of hedgers and some money managers. However, due to their significantly lower market share, their positions shifts in futures had an insignificant impact. Beyond that, and following Flassbeck *et al.* (2011), since agricultural futures prices tended to be less driven by fundamental factors it may have discouraged traditional hedgers to follow hedging strategies. For instance, considering corn again, the ratio of report and pre and post-report variance for WASDE and NASS months decreased from 17.69 to 7.87 and 5.02 in the 2006/07 and 2008/09 subsamples, respectively.

Table 7 - CBOT Futures Return Volatility Test for WASDE reports, Subsamples

		Soybeans					Wheat					Corn				
Report Group	***N***	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X^2* Test**	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X^2* Test**	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre-/ Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X^2* Test**
							January 1998 - December 2001									
All Months	48	2.39	0.53	1.87	4.54***	11.85***	1.00	0.43	0.56	2.30***	6.78***	2.11	0.76	1.36	2.79***	3.31
WASDE and NASS	20	5.10	0.41	4.69	12.42***	19.62***	1.36	0.35	1.01	3.88***	11.44***	4.11	0.46	3.65	8.95***	10.22***
WASDE	28	0,58	0.61	-0.03	0.95	1.11	0.78	0.49	0.29	1.58**	0.26	0.79	0.97	-0.18	0.81	1.57
							January 2002 - December 2005									
All Months	48	4.07	0.73	3.34	5.60***	9.31***	1.56	0.49	1.07	3.19***	10.02***	3.50	0.59	2.90	5.88***	14.43***
WASDE and NASS	20	9.35	0.70	8.65	13.44***	25.76***	3.10	0.59	2.51	5.28***	5.75*	7.87	0.45	7.43	17.69***	31.13***
WASDE	28	0.51	0.75	-0.24	0.68	3.77	0.54	0.42	0.12	1.28	6.15**	0.55	0.70	-0.15	0.79	2.80
							January 2006 - December 2007									
All Months	24	1.28	0.62	0.66	2.06***	4.03	1.63	1.04	0.59	1.57*	7.25**	5.60	1.34	4.26	4.17***	4.90*
WASDE and NASS	10	2.39	0.68	1.71	3.52***	2.92	2.65	1.42	1.23	1.87*	2.31	9.83	1.25	8.58	7.87***	4.95*
WASDE	14	0.62	0.48	0.13	1.28	2.46	1.05	1.01	0.04	1.04	5.60	3.11	0.89	2.21	3.48	1.27
							January 2008 - December 2009									
All Months	24	4.43	2.02	2.41	2.19***	0.34	3.07	2.03	1.05	1.52**	0.31	6.48	2.36	4.12	2.74***	2.26
WASDE and NASS	10	9.63	2.72	6.91	3.54***	1.54	6.02	2.38	3.64	2.53**	3.16	15.07	3.00	12.07	5.02***	8.70**
WASDE	14	1.18	1.94	-0.76	0.61	0.05	1.27	1.70	-0.43	0.75	0.91	1.04	2.14	-1.10	0.49	2.57
							January 2010 - December 2012									
All Months	36	3.55	0.76	2.79	4.69***	7.30**	6.64	1.99	4.65	3.34***	6.24**	5.95	1.48	4.47	4.03***	8.36**
WASDE and NASS	15	7.86	1.01	6.85	7.76***	6.46**	13.85	2.10	11.75	6.60***	14.60***	10.56	1.67	8.89	6.32***	6.89**
WASDE	21	0.71	0.57	0.13	1.23	1.69	1.93	1.91	0.02	1.01	1.24	3.02	1.34	1.68	2.25***	2.95

Note: Returns are computed as the difference close-to-open in natural logarithm prices multiplied by 100. *N* denotes the number of WASDE reports released. Continuous futures contract are used (Datastream methodology futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires). (*) indicates significance at the 10% level. (**) denotes significance at the 5% level. (***) indicates significance at the 1% level. The WASDE and NASS group includes releases during August through November and January. The WASDE group includes releases WASDE releases in December and from February through July. Report Sessions Variance is function (5); Pre-Post Report Sessions Variance is function (6); *F*-Statistic is function (7); Kruskal- Wallis X^2 is the non-parametric test.

More recently, in the last sub-period, results returned to be consistent with the entire sample results. Considering that market structure had changed significantly, with hedgers holding in 2012 the same amount or more agricultural commodities futures positions than index traders (Open interest – see Figure 2), these results suggest that when market structure is balanced between hedgers and speculators, WASDE reports continue to change market participants expectations. For example, the ratio of report and pre and post report variance in soybeans increased from 3.54 to 7.76 in this last sub-period on WASDE and NASS months.[27]

For European commodities, the subsamples period analysis is presented in Table 8. For the first thee subsamples, results suggest that return variance on report session release days is generally similar to pre and post report variance sessions for wheat and corn, since the null hypothesis that return variability is equal could not be rejected for any. For the fourth sub-period, results are marginally significant for corn in WASDE and NASS reports months, however for soybeans results continue to not reject the null hypothesis. Most important, in the last subsample, variance on report sessions is significantly higher than on pre and post report session for both commodities.[28] These results suggest that WASDE and NASS reports suddenly started to change substantially market participants' expectations regarding the subsequent futures/spot prices. Perhaps, European traders of Euronext wheat and corn futures began to follow WASDE reports more closely or the uncertainty regarding future market conditions was higher.[29]

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[27] These results are supported with Appendix 3 5 daily return variance around the event window days. From 2006 through 2009, return variance in pre and post report days is substantially higher when compared with other sub-periods.

[28] Appendix 6 denotes the increase in return variance in report session in the last sub-period.

[29] According to Isengildina-Massa *et al.* (2008, p. 100), WASDE reports "information is more valuable when uncertainty regarding futures market conditions is higher".

Table 8 - Euronext Futures Return Volatility Test for WASDE reports, Subsamples

	Wheat						Corn					
Report Group	***N***	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre- / Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X*^2 Test**	***N***	**Report Sessions Variance**	**Pre-Post Report Sessions Variance**	**Difference in Report and Pre- / Post Report Session variance**	***F*- Statistic**	**Kruskal - Wallis *X*^2 Test**
			January 1998 - December 2001						**October 1999 - December 2001**			
All Months	48	0.26	0.43	-0.17	0.61	0.30	27	0.12	0.05	0.07	2.39***	1.45
WASDE and NASS	20	0.26	0.36	-0.10	0.71	0.49	12	0.10	0.04	0.06	2.52***	2.97
WASDE	28	0.28	0.48	-0.21	0.57	1.31	15	0.15	0.06	0.09	2.46***	0.02
						January 2002 - December 2005						
All Months	48	0.49	0.63	-0.14	0.78	0.34	48	0.26	0.54	-0.28	0.48	2.01
WASDE and NASS	20	0.33	0.51	-0.18	0.65	0.50	20	0.32	0.46	-0.15	0.69	0.49
WASDE	28	0.62	0.71	-0.09	0.88	1.43	28	0.24	0.61	-0.37	0.39	0.52
						January 2006 - December 2007						
All Months	24	0.86	1.01	-0.15	0.85	0.86	24	0.85	1.00	-0.15	0.85	0.17
WASDE and NASS	10	1.31	1.58	-0.27	0.83	1.91	10	1.38	1.56	-0.18	0.88	1.38
WASDE	14	0.61	1.13	-0.52	0.54	2.59	14	0.55	1.11	-0.57	0.49	0.88
						January 2008 - December 2009						
All Months	24	0.91	1.41	-0.50	0.64	1.90	24	2.02	1.61	0.42	1.26	2.08
WASDE and NASS	10	0.95	1.61	-0.66	0.59	2.38	10	3.55	1.78	1.77	2.00**	3.09
WASDE	14	0.95	1.15	-0.20	0.83	0.21	14	1.12	1.27	-0.15	0.88	2.19
						January 2010 - December 2012						
All Months	36	2.70	1.36	1.34	1.99***	0.32	36	2.21	1.19	1.02	1.86***	4.65*
WASDE and NASS	15	6.08	1.29	4.79	4.71***	4.14	15	4.89	1.33	3.56	3.67***	8.24**
WASDE	21	0.46	1.40	-0.94	0.33	2.89	21	0.44	1.08	-0.65	0.40	2.37

Note: Returns are computed as the difference Open-to-Close in natural logarithm prices multiplied by 100. *N* denotes the number of WASDE reports released. Continuous futures contract are used: a Datastream methodology - futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires). (*) indicates significance

at the 10% level. (**) denotes significance at the 5% level. (***) indicates significance at the 1% level. The WASDE and NASS group includes releases during August through November and January. The WASDE group includes releases WASDE releases in December and from February through July. Report Sessions Variance is function (8); Pre-Post Report Sessions Variance is function (9); *F*-Statistic is function (7); Kruskal- Wallis X^2 is the non-parametric test.

4.3. Empirical Results for WASDE Release Impact in Context

Following the practice of Adjemian (2011), for CBOT commodities futures, the average impact of WASDE reports releases on the holder of each futures contract is measured against its maintenance margin (collateral). Absolute close-to-open returns are used, since futures traders can profit either from holding a short or a long position. This analysis is presented in Table 9.

Table 9 - WASDE Release Impact in CBOT Commodities Context, 1998-2012

	CBOT Soybeans Futures			**CBOT Wheat Futures**			**CBOT Corn Futures**		
	Impact on Returns	Impact per Contract	Return on Collateral (a)/(b)	Impact on Returns	Impact per Contract	Return on Collateral (a)/(b)	Impact on Returns	Impact per Contract	Return on Collateral (a)/(b)
Avg. Report - Mean Price	1.14%	$458	15.81%	1.08%	$247	14.98%	1.37%	$234	13.38%
Avg. Report - High Price	1.14%	$1,007	34.74%	1.08%	$694	42.05%	1.37%	$559	31.93%

Note: Announcement effects on returns are estimated using the absolute Close-to-Open log returns (price changes) on a WASDE release day across the all sample. Maintenance margin represent the per contract collateral that a trader must post to maintain a futures position - value collected for the current nearest future contracts as of January 2014 for soybeans and December 2013 for wheat and Corn. The effect per contract is based on the mean settlement price level and the future contract size, which is 5,000 bushels for the three commodities. **(a)** The WASDE information shock is translated into an absolute value of the single day return on collateral (Maintenance Margin). **(b)** Maintenance Margin Required per Contract for Soybeans is $2,900, for Wheat is $1,650, and for Corn is $1,750.

As illustrated in Table 9, the average WASDE report increases soybeans price volatility by 1.14% on release days (average of absolute returns on report days across the entire sample). CBOT Soybean futures are traded in 5,000 bushels contracts. At the mean closing soybeans price of $8.05 per bushel, Table 9 shows that WASDE releases shifts the value of each futures soybeans contracts by $458, on par with nearly a 16% return collateral (margin) on a single day. Evaluated at soybeans maximum per bushel price level of $17.46, a 1.14% change is equivalent to almost $1,007 per contract, or an immediate change in value about equal to 34% of the maintenance margin.

Returns on CBOT wheat futures contracts are estimated to respond to WASDE releases by 1.08%, configuring a shock of $247 per contract – a nearly 15% return on collateral – at the mean closing price level of $4.57 per wheat bushel, since each contract represents 5,000 bushels. At the high of $9.09 per wheat bushel, a similar surprise corresponds to a $695 impact per contract, or a 42% of the required margin level.

Finally, CBOT corn futures prices shift at an average of 1.37% following a WASDE report release. At the mean corn price between 1998 and 2012, this increase is equivalent to a $234 per contract price swing, or almost 14% of that contract's collateral. At corn's maximum price, WASDE impacts the value of a trader's margin account by $559, a more than 31% return on collateral.

These results indicate that on average CBOT soybeans, wheat and corn market participants between 1998 and 2012 may have profited with a strategy of entering into a future contract position (short or long) at the settlement price in the day before the release, and selling it at the opening price of the WASDE report release day. In other words, these results quantifies the previous findings of Table 5 that WASDE reports release contain valuable information to significantly change future market participants expectations.

5. Conclusion

The purpose of this dissertation is to study the impact and information value of the World Agricultural Supply and Demand Estimates (WASDE) reports in soybeans, wheat and corn futures contracts traded in the Chicago Board of Trade (CBOT) and in wheat and corn futures contracts traded in Euronext over the period 1998 to 2012. The research is based on an event study approach, with the "events" consisting of all monthly WASDE reports releases.

Consistent with prior research, empirical results for CBOT commodities in this study show that the release of the WASDE report is followed by an immediate impact in the opening futures price, suggesting that WASDE reports provide valuable information to substantially change market participants expectations and reduce uncertainty regarding subsequent futures and spot prices.

In detail, for CBOT soybeans, wheat and corn futures, the empirical analysis suggest three main findings. First, as expected based on previous research, the WASDE reports are more important to futures markets in certain months. Precisely, the months that include WASDE and NASS crop production forecasts (from August to November plus January) have the largest impact on CBOT commodities: return variance on release session (the “event day”) is significantly greater than pre and post-report session’s variance. Second, for WASDE reports months containing only international situation and domestic and international outlook information (from February to July plus December), the impact is much smaller compared to the other group of months. Third, for a sub-period analyzes, CBOT results present that the impact of WASDE reports has decreased in the 2006-09 period. This period was remarked with unprecedented prices volatility, with the largest inflow of money into agricultural commodities futures in history, and when a new market participant, index traders, came to play a major role in futures market structure. Taking this into account and that return variance was higher in pre and post report sessions, these results suggest that the growing presence of speculators changed market conditions substantially. As so, WASDE reports might included valuable information to change market participants expectations, nonetheless the unprecedent volatility may have discouraged traditional hedgers to follow hedging strategies.

Concerning European commodities, results are much smaller in comparison to CBOT results, indicating that WASDE reports might not contain extremely valuable information concerning European commodities crops to change market participants' expectations. However, results suggest that WASDE reports release impact in Euronext wheat and corn futures have a similar pattern as the one denoted in CBOT commodities: WASDE and NASS reports months group has higher impact on the variability of futures returns. Furthermore, results evidence that the impact of WASDE and NASS reports has increased over time.

Overall, price impact analyses in this dissertation suggest that WASDE and NASS reports have substantial information value. Thus, this study contributes new evidence regarding the value of reports information for CBOT from 2006 through 2012 and for Euronext, since this is the first study comprising European commodities.

Further research for CBOT commodities is needed to better understand the decrease in markets impact to WASDE reports releases between 2006 and 2009. This will allow hedgers to be better protected in the future against these impacts. Moreover, further research may investigate the impact of WASDE reports for others countries commodities futures markets, and continue to follow more closely the impact on Euronext.

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7. Appendixes

Appendix 1 – Major Agricultural Commodity Futures Exchanges

Futures Exchange	Abbreviation	Internet Address
Chicago Board of Trade	CBOT / COMEX	[http://www.cbot.com]
Minneapolis Grain Exchange	MGE	[http://www.mgex.com]
Kansas City Board of Trade	KCBOT	[http://www.kcbot.com]
New York Cotton Exchange	NYCE	[http://www.nyce.com]
Winnepeg Grain Exchange	WCE	[http://www.wce.ca]
Buenos Aires Cereals Exchange	BOLSA	[http://www.bolsadecereales.com]
Rosario Futures Exchange	ROFEX	[http://www.rofex.com.ar]
European Union Commodity Futures	Euronext.liffe	[http://www.euronext.com]
South African Futures Exchange	SAFEX	[http://www.safex.co.za]

Source: Schnepf, 2006

Appendix 2 - Major Agricultural Commodity Futures Contracts, Futures Exchanges, and Contract Months

Commodity specification [b] **Exchange**	**Ticker Symbol**	**Futures Exchange**	**Contract Months**[a]
Wheat, No. 2, Soft Red Winter	W	CBOT	N,U,Z,H,K
Rough Rice, No. 2	RR	CBOT	U,Z,H,K,N
Oats, No. 2 Heavy	O	CBOT	N,U,Z,H,K
Corn, No. 2 Yellow	C	CBOT	Z,H,K,N,U
Soybeans, No. 2 Yellow	S	CBOT	U,X,F,H,K,N,Q
Soybean Oil, crude	BO	CBOT	V,Z,F,H,K,N,Q,U
Soybean Meal, 48% protein	SM	CBOT	V,Z,F,H,K,N,Q,U
Wheat, No. 2 Northern Spring	MW	MGEc	H,K,N,U,Z
Hard Red Winter Wheat indexd	HRWI	MGE	All months
Hard Red Spring Wheat Indexd	HRSI	MGE	All months
Soft Red Winter Wheat indexd	SRWI	MGE	All months
National Corn indexd	NCI	MGE	All months
National Soybean indexd	NSI	MGE	All months
Wheat, No. 2, Hard Red Winter	KW	KCBOT	N,U,Z,H,K
Cotton, No. 2, 1 1/16 inch	CT	NYCE	H,K,N,U,Z
Feed Wheat	WW	WCE	H,K,N,V,Z
Canola, No. 1 Canada	RS	WCE	F,H,K,N,U,Z
Barely, No. 1 Canada Western	AB	WCE	H,K,N,V,Z
Milling Wheat, European	na	Euronext	F,H,K,N,U,X
Feed Wheat, European	na	Euronext	F,H,K,N,U,X
Corn, French yellow	na	Euronext	F,H,M,Q,X
Rapeseed, any origin	na	Euronext	F
White Maize	WMAZ	SAFEX	H,K,N,U,Z
Yellow Maize	YMAZ	SAFEX	H,K,N,U,Z
Wheat	WEAT	SAFEX	H,K,N,U,Z
Sunflower	SUNS	SAFEX	H,K,N,U,Z

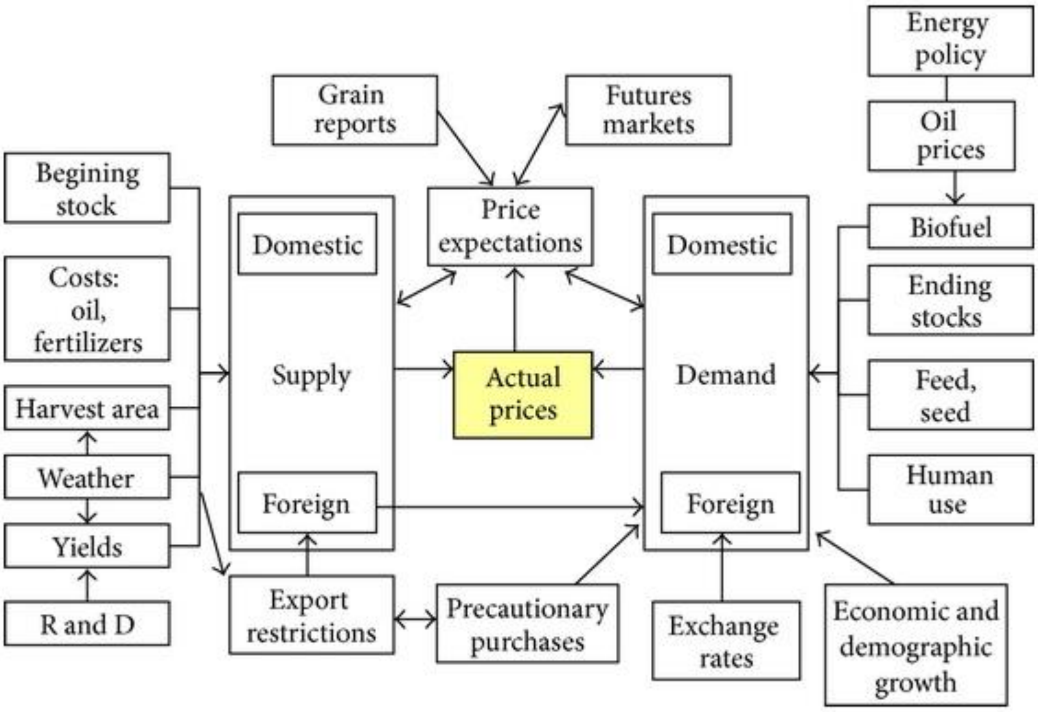
Source: Schnepf, 2006

na = not applicable.

a. Jan = F; Feb = G; Mar = H; Apr = J; May =K ; June = M; July = N; Aug. = Q; Sep. = U; Oct. = V; Nov. = X; and Dec. = Z.

b. Refer to the contract specification information available at each exchanges website provided in Appendix 1.

Appendix 3 - The Nature of Agricultural Commodity Price Formation



Source: Retizis and Sassi (2013)

Appendix 4 - Major USDA Report Releases – Key USDA Crop and Market Information Report

Month	Year	Report Title	Contents
January	T	*Winter Wheat & Rye Seedings*	1st Estimate of Planted are for U.S. winter wheat and rye
January	T	*Grain Stocks*	Estimate of U.S. stocks by position (on and off-farm) for all wheat, coarse grains, and oilseeds on January 1.
January	T	*WASDE*	WASDE + NASS Crop Estimates "mix"
February	T	*WASDE*	WASDE "pure" outlook information
March	T	*Prospective Planting*	Planting intentions for U.S. spring planted crops.
March	T	*Grain Stocks*	Estimate of U.S. stocks (on and off-farm) for all wheat, coarse grains, and oilseeds on March 1.
March	T	*Rice Stocks*	Estimate of U.S. stocks by type for milled and rough rice on March 1.
March	T	*WASDE*	All available Supply and Use Balance; Estimate on ending stock for T-1 year; Supply and consumption estimates; "pure" outlook information
April	T	*WASDE*	All available Supply and Use Balance
May	T	*Crop Production*	1st estimate of yield and harvested area for U.S. winter wheat.
May	T	*WASDE*	1st projection for marketing year (T/T+1) of: U.S. season average farm prices; U.S. and foreign supply and use balance for rice, cotton, oilseeds, wheat, and course grains; and foreign country for coarse grains and wheat. "pure"
June	T	*Grain Stocks*	Estimate of U.S. (stocks on and off-farm) for all wheat, coarse grains, and oilseeds on June 1.
June	T	*WASDE*	All available Supply and Use Balance updated based on new market information; "pure"
June	T	*Acreage*	1st estimate of planted area for U.S. spring planted crops.
July	T	*Crop Production*	1st estimate of yield for U.S. spring wheat, barley, oats, durum, and rye. 1st production estimate based on June acreage estimate of harvested area for major crops.
July	T	*WASDE*	1st projections for foreign country supply and use balance for rice, cotton, and oilseeds. All available supply and use balance are updated based on new crop and market information. "Pure"
September	T	*Crop Production*	New yield estimates and possible harvested area adjustments for U.S. coarse grains, rice, cotton, oilseeds, sugar cane, and sugar beets.
August	T	*Crop Production*	1st estimate of yield and harvested are for U.S. coarse grains, rice, cotton, oilseed, sugar cane, and sugar beets.

August	T	*WASDE*	All supply and use balance are updated based on new crop and market information. "Mix"
September	T	*WASDE*	All Supply and Use balances are updated based on new crop and market information. "Mix"
October	T	*Rice Stocks*	Estimate of U.S. stocks by type for milled and rough rice on October 1.
October	T	*Crop Production*	New yield estimates and possible harvested are adjustments for U.S. coarse grains, rice, cotton, oilseed, sugar cane, and sugar beets.
October	T	*WASDE*	All Supply and Use balances are updated based on new crop and market information. "Mix"
November	T	*Crop Production*	New yield estimates and possible harvested are adjustments for U.S. coarse grains, rice, cotton, oilseed, sugar cane, and sugar beets.
November	T	*WASDE*	All Supply and Use balances are updated based on new crop and market information. "Mix"
December	T	*Crop Production*	New yield estimates and possible harvested are adjustments for U.S. cotton,
December	T	*WASDE*	All Supply and Use balances are updated based on new crop and market information. "Pure"
January	T+1	*Crop Production, WASDE*	Final planted and harvested are, yield and production for U.S. crops. "Mix"
January	T+1	*Winter Wheat & Rye Seeding*	Final planted and harvested area for U.S. winter wheat.

Source: Schnepf (2006); USDA; NASS.

Appendix 5 – Event Window for CBOT Return Variance

SOYBEANS CBOT

Event Window days around the WASDE announcement - Futures Volatility Returns, Close-to-Open Returns, Jan. 1998-Dec- 2012 and Subgroups

			Subgroups				
Trading Day Relative to WASDE Release	***N***	**Close to Open Return Variance (All Sample)**	**Close to Open Return Variance (98-01)**	**Close to Open Return Variance (02-05)**	**Close to Open Return Variance (06-07)**	**Close to Open Return Variance (08-09)**	**Close to Open Return Variance (10-12)**
-5	180	0,69	0,31	0,93	0,53	1,37	0,63
-4	180	0,97	0,56	0,44	0,87	3,65	0,67
-3	180	0,83	0,40	1,10	0,70	1,79	0,62
-2	180	0,67	0,65	0,51	0,41	1,46	0,62
-1	180	0,57	0,29	0,46	0,55	1,65	0,45
0	**180**	**3,15**	**2,39**	**8,33**	**1,28**	**4,43**	**3,55**
1	180	0,91	0,62	1,35	0,62	2,24	1,04
2	180	0,59	0,22	1,10	0,82	1,25	0,62
3	180	0,83	0,51	1,70	0,31	2,19	0,80
4	180	0,84	0,59	1,57	0,64	2,05	0,72
5	180	0,69	0,71	0,88	0,40	1,36	0,83

WHEAT CBOT

			Subgroups				
Trading Day Relative to WASDE Release	***N***	**Close to Open Return Variance (All Sample)**	**Close to Open Return Variance (98-01)**	**Close to Open Return Variance (02-05)**	**Close to Open Return Variance (06-07)**	**Close to Open Return Variance (08-09)**	**Close to Open Return Variance (10-12)**
-5	180	1,37	0,65	0,48	1,73	2,07	3,00
-4	180	0,95	0,57	0,42	0,97	2,68	1,11
-3	180	1,03	0,26	0,51	0,91	2,00	2,30
-2	180	0,89	0,51	0,65	0,95	1,07	1,65
-1	180	0,78	0,30	0,41	1,17	1,18	1,49
0	**180**	**2,61**	**1,00**	**3,16**	**1,63**	**1,63**	**6,64**
1	180	0,88	0,24	0,81	0,56	2,64	1,54
2	180	0,82	0,28	0,85	1,19	1,70	1,35
3	180	1,08	0,43	1,42	0,69	2,62	1,83
4	180	0,78	0,42	0,57	0,89	1,58	1,44
5	180	0,97	0,34	0,52	0,72	1,48	2,72

CORN CBOT

			Subgroups				
Trading Day Relative to WASDE Release	***N***	**Close to Open Return Variance (All Sample)**	**Close to Open Return Variance (98-01)**	**Close to Open Return Variance (02-05)**	**Close to Open Return Variance (06-07)**	**Close to Open Return Variance (08-09)**	**Close to Open Return Variance (10-12)**
-5	180	1,33	0,67	0,71	2,51	1,49	2,30
-4	180	1,23	0,71	0,52	1,38	4,04	1,09
-3	180	1,00	0,34	0,74	1,19	2,69	1,11
-2	180	0,90	0,70	0,65	0,60	1,88	1,14
-1	180	0,84	0,43	0,42	1,50	1,78	1,02
0	**180**	**4,24**	**2,11**	**7,15**	**5,60**	**6,48**	**5,95**
1	180	1,50	0,78	0,97	1,81	3,00	2,82
2	180	0,82	0,51	0,90	1,36	1,92	0,77
3	180	0,95	0,63	1,60	0,70	1,94	1,22
4	180	0,96	1,20	0,72	0,86	2,22	0,82
5	180	0,87	0,99	0,74	0,69	1,25	1,38

Note: Returns are computed as the difference close-to-open in natural logarithm prices multiplied by 100. *N* denotes the number of WASDE reports released in the sample period. Continuous futures contract are used (Datastream methodology - futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires).

Appendix 6 - Event Window for Euronext Return Variance

Euronext
Wheat
Event Window days around the WASDE announcement - Futures Volatility Returns, Close-to-Open Returns, Jan. 1998-Dec- 2012 and Subgroups

			Subgroups				
Trading Day Relative to WASDE Release	***N***	**Close to Open Return Variance (All Sample)**	**Close to Open Return Variance (98-01)**	**Open-to-Close Return Variance (02-05)**	**Open-to-Close Return Variance (06-07)**	**Open-to-Close Return Variance (08-09)**	**Open-to-Close Return Variance (10-12)**
-5	180	0,74	0,25	0,47	0,66	1,26	1,54
-4	180	0,95	0,21	0,59	2,31	1,23	1,44
-3	180	0,90	0,38	0,91	0,91	1,59	1,24
-2	180	0,73	0,28	0,58	0,94	1,00	1,32
-1	180	0,52	0,35	0,50	0,90	0,48	0,64
0	**180**	**0,94**	**0,24**	**1,01**	**0,86**	**0,91**	**2,70**
1	180	0,79	0,28	0,77	0,81	2,44	1,04
2	180	0,77	0,54	0,82	0,33	2,31	0,93
3	180	0,78	0,35	1,85	0,81	0,78	1,25
4	180	0,85	0,65	1,00	1,09	0,84	1,57
5	180	0,89	0,68	1,10	0,72	1,34	1,56

Note: Returns are computed as the difference Open-to-Close in natural logarithm prices multiplied by 100. *N* denotes the number of WASDE reports released in the sample period. Continuous futures contract are used (Datastream methodology - futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires).

Euronext
Corn
Event Window days around the WASDE announcement - Futures Volatility Returns, Close-to-Open Returns, Jan. 1998-Dec- 2012 and Subgroups

			Subgroups				
Trading Day Relative to WASDE Release	***N***	**Close to Open Return Variance (All Sample)**	**Close to Open Return Variance (98-01)**	**Open-to-Close Return Variance (02-05)**	**Open-to-Close Return Variance (06-07)**	**Open-to-Close Return Variance (08-09)**	**Open-to-Close Return Variance (10-12)**
-5	159	0,55	0,03	0,11	0,40	1,34	1,15
-4	159	0,73	0,05	0,15	1,34	1,42	1,23
-3	159	0,67	0,02	0,31	1,05	1,62	0,84
-2	159	0,78	0,03	0,40	1,18	1,49	1,20
-1	159	0,41	0,04	0,20	0,59	0,65	0,71
0	**159**	**0,99**	**0,12**	**0,33**	**0,85**	**2,02**	**2,21**
1	159	0,79	0,09	0,60	0,98	2,67	0,69
2	159	0,69	0,03	0,36	0,89	2,43	0,68
3	159	0,78	0,05	0,88	0,98	0,64	1,82
4	159	0,46	0,08	0,45	0,17	1,27	0,78
5	159	0,99	0,07	0,55	1,80	1,53	1,88

Note: Returns are computed as the difference Open-to-Close in natural logarithm prices multiplied by 100. *N* denotes the number of WASDE reports released in the sample period. Continuous futures contract are used (Datastream methodology - futures price of the most recent contract and pricing automatically rolls over to the nearest contract when the original contract expires).

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